THE

FOUNDRY TRADE JOURNAL

WITH WHICH IS INCORPORATED

THE IRON AND STEEL TRADES JOURNAL

VOL. 44. Thursday, February 5, 1931. No. 755.

PUBLISHED WEEKLY.

Subscription Terms: 15s. per annum.
Foreign and Colonial: 17s. 6d. per annum.
All Subscriptions are payable in advance.

All Communications to be addressed to the Editor, or to the Publisher, as the case may be, of

THE FOUNDRY TRADE JOURNAL,
49, WELLINGTON STREET, LONDON, W.C.2.

Telegraphic Address: "Zacatecas, Rand, London."
Telephone: Temple Bar 3951 (4 lines).

Contents.

	PAGE
Forthcoming Events	99
Our Position Defined	99
Testing Materials	99
Correspondence	100
Carron Company's Annual Dinner	100
Random Shots	100
Presentation to Ex-Bailie John King	101
The American Foundrymen's Association's 1931 Convention	101
Contracts Open	101
Cupola Malleable Cast Iron	102
Progress in Metallurgical Research	105
Purchasing Electrical Plant	106
A Survey of Light-Castings Manufacture	107
The Manufacture and Properties of Malleable Castings	110
Patent Specifications Accepted	112
A Novel Combination Jolt-Squeeze Moulding Machine	113
Deoxidation of Steel	114
Postmasburg Manganese Ore	114
Trade Talk	116
Obituary	116
New Companies	116
Iron and Steel Markets	118
Students' Corner	118

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

Institute of British Foundrymen.

PRESIDENT: 1930-31:
F. P. Wilson, J.P.,
"Parkhurst," Middlesbrough.

LIST OF SECRETARIES—

General Secretary: T. Makemson, Saint John Street Chambers, Deansgate, Manchester. London Office: 49, Wellington Street, London, W.C.2.

Birmingham: F. K. Neath, 24, St. Paul's Square, Birmingham.

Sheffield: T. R. Walker, 33, Ladysmith Avenue, Nether Edge, Sheffield.

Scottish: J. Bell, 60, St. Enoch Square, Glasgow.

Lancashire: W. Gilpin, "Sunnyside," Birch Grove, Rusholme, Manchester.

London: Dr. A. B. Everest, Mond Nickel Company, Limited, Imperial Chemical House, Millbank, London, S.W.1.

Newcastle-upon-Tyne: F. Sanderson, 1, Ellwood Gardens, Gateshead-upon-Tyne.

East Midlands: H. Bunting, 82, Otter Street, Derby.

West Riding of Yorkshire Branch: S. W. Wise, 110, Pullan Avenue, Eccleshill, Bradford.

Wales and Monmouth Branch: J. J. McClelland, 12, Clifton Place, Stow Hill, Newport, Mon.

Middlesbrough: F. A. Harper, "The Briars," Bishopton Road, Stockton-on-Tees.

Foundry Trades Equipment and Supplies Association.

President: A. S. Beech,
13 to 15, Wilson Street, London, E.C.2.

Secretary: K. W. Bridges, Grand Buildings, Trafalgar Square, London, W.C.2.

Welsh Engineers' and Founders' Association.

Secretary: E. J. Griffiths, 2, Royal Metal Exchange, Swansea.

Forthcoming Events.

FEBRUARY 10.

Institute of Metals (North-East Coast Local Section):—Ordinary meeting. "Stress in Metals," Paper by A. Wragg.

FEBRUARY 12.

Institute of Metals (London Local Section):—Ordinary meeting in London. "Electrolytic Processes in Metallurgy," Paper by J. T. Ellingham, Ph.D.

Institution of Welding Engineers:—Ordinary meeting in London. "Welding Practices and Methods based on My Own Experiences," Paper by the Prizewinner.

Institute of British Foundrymen.

FEBRUARY 10.

Lancashire Branch (Burnley Section):—Ordinary meeting. "Mass Production from Cheap Plant," Paper by L. Wharton.

FEBRUARY 12.

Birmingham, Coventry and West Midlands Branch:—Symposium of Short Papers on "Moulding Methods."

FEBRUARY 13.

Middlesbrough Branch:—Ordinary meeting.

FEBRUARY 14.

Lancashire Branch:—Ordinary meeting at Manchester. "Weldings as a New Foundry Application," Paper by P. L. Roberts.

Our Position Defined.

Inasmuch as we have been reproached in the correspondence column for our attitude to weldings as competitive with castings, we are taking this opportunity of stating clearly our policy. Primarily, we recognise that the welding process has converted many a faulty casting into a saleable machine part, and thus we acknowledge the indebtedness of the foundry to that industry. The reclamation of castings broken in service certainly robs the foundry industry of many valuable orders, but again the fact that the products of the foundry are repairable is perhaps a bull point.

The third aspect is where new structures are fabricated from weldings in places where castings are normally used, and it is our attitude to this question that we are desired to outline. We believe that, whilst it has its definite field in engineering, enthusiasm for the new method has carried its adoption beyond the bounds of reason. The use of weldings for street distribution, junction and feeder boxes made from very thin steel plates has resulted in their being corroded right through at the base in a very short time. This is typical of the favour accorded to the welding industry which is withheld from the foundries, as it represents a job which can be better done in the foundries, and probably as cheaply if ordered in reasonable quantities. Thus our first point is that the foundry industry demands full recognition and consultation in the design of structures in order that they can be assured that their method of producing fabricated structures has been given fair play. Our second attitude is that the result of constant exchange of ideas and experience between welders and founders will create for the engineer a product which will be a combination of the two processes. Welders must realise that founders have a legitimate "grouse" in that the latter are often not permitted to use the welding process for effecting minor repairs, yet they are expected silently to watch this very process making competition with them for the finished article.

In their own interests the welding community should use their influence with the inspecting authorities to have permission granted for the rehabilitation of slightly defective castings by approved welding processes.

Mr. Steel must like ourselves be well aware that quite a number of firms are both founders and welders, and this very fact naturally precludes us from "attacking" the industry, and all that we have done and intend to do is to bring about a measure of co-operation for mutual benefit.

Testing Materials.

We referred some time ago in these columns to the attempt to revive what was known before the war as the International Association for Testing Materials, and which has actually come to fruition as the New International Association for Testing Materials. It has already justified its existence by the publication of a handsome and well-produced volume called "First Communications of the N.I.A.T.M." This is in two parts, the first dealing with the metals and the second with other materials. The former contains some fifty Papers, of which the excellent proportion of one-fifth is by British authors. Each Paper is printed in one of three languages most familiar to the author, English, French or German, but there is an abstract of each Paper in all these languages.

We have a particular reason for referring to this publication, because it emanates from a group of men taking very wide views of the general subject, the metals. It is very significant that pride of place in the volume should be given to cast iron, and no less than four Papers are exclusively devoted to the question of testing cast iron, the first of these coming from the Cast Iron Research Association. The other contributing countries on this matter are Germany, Switzerland and Czecho-Slovakia. Other aspects of cast iron are dealt with by contributors from the United States of America, Switzerland and Czecho-Slovakia.

This is a very striking illustration of the advance in the metallurgical importance of cast iron during the period that has elapsed since the last meeting of the old international association took place in New York in 1913, and the emergence of the material from its earlier status to a higher plane, and the share which this country has had in producing this result must be a source of satisfaction to all founders here.

Our readers will not have forgotten the question of an internationally-agreed method of testing cast iron, which has proved a very controversial matter. It is bound to arise in future. Now the body referred to above, the N.I.A.T.M., will have no power to settle this matter or exercise jurisdiction over it. It has, in fact, definitely undertaken not to touch the direct question of specification of materials, in which important commercial interests are involved. It aims at an international exchange of ideas, and its proper function would be to review at intervals the progress made in each country. The Papers presented already, however, make it clear that the new body will be used to some extent as a forum, and victory is likely to go to those who can make a most convincing statement of their case and so secure the support of eminent metallurgists who can take a disinterested and impartial view, free from the effects of enthusiasms of particular workers for particular methods. The issue is already joined. It will be carried on at the meeting of the new body scheduled to be held in Zurich next September.

XUM

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Castings *versus* Weldings.

To the Editor of The Foundry Trade Journal.

Sir,—I notice that from time to time you have something to say about welding in general and weldings in particular. As the manufacture of the latter vitally affects the foundry industry, the prosperity of which you have at heart, it is not to be expected that you view weldings with favour.

Assuming, then, that your attitude towards this new process of manufacture is antagonistic, it is easy to understand why your remarks concerning it are invariably of a disparaging nature. Firemen know that it is useless to try and fight their enemy with a hand-squirt, and if you wish really to help the foundry industry to meet successfully this new form of competition, it is high time you altered your tactics.

Far better for the foundry industry for you to throw open your journal to a full and free discussion of the subject. As a result, ideas might come to light which would be helpful to foundrymen, and suggest ways and means to them of coping with this menace to their welfare and prosperity.

Almost daily I see the progress which this new method is making against foundry interests. That there must be some advantage to be gained by its adoption is surely evident when hard-headed executives are spending money on welding equipment and not on foundry plant.

Whilst severely critical of your attitude, I nevertheless congratulate you on selecting the weak points in the case for weldings and concentrating your attack upon them.

On the other hand there is no excuse for you refraining from pointing out the advantages of the process, so that your readers may be informed on both sides of the question. Once familiar with the advantages claimed for weldings over castings, they may be best informed as to how they may go one better.—Yours, etc.,

Wm. Steel,
Welding Consultant to Suffolk Iron Foundry (1920), Limited.

January 29, 1931.

[We deny *in toto* that we have assumed anything but a scrupulously fair attitude to the welding industry. The very title—"The Final Outcome"—of the last leading article we wrote on the subject was indicative of an earnest desire for co-operation, as the "final outcome" referred to a prophecy we hazarded that the "ultimate outcome in structural engineering would be the fabrication of bases and shells by casting and the addition of brackets and the like by welding."—Editor.]

Notes from I.B.F. Branches.

Sheffield Branch.—The annual dinner will be held on Friday, February 13, in the King's Head Hotel, Sheffield, at 7.30 p.m. The speakers will include the Lord Mayor of Sheffield, the Master Cutler, Mr. A. J. Grant (managing director of John Brown & Company, Limited), and Mr. A. Harley (Senior Vice-President of the Institute). The function is open to members and friends, and tickets may be obtained from Mr. T. R. Walker, 33, Ladysmith Avenue, Nether Edge, Sheffield.

A contract has been placed by the managers of the Nelson Line with Messrs. Harland & Wolff, Limited, of Belfast, for a new motor-liner of about 14,000 tons gross, to take the place of the "Highland Hope."

Carron Company's Annual Dinner.

The annual dinner of the Carron Company was held in the Dobbie Hall, Larbert, on January 24, when the staff were the guests of the company. Mr. George Pate, O.B.E., J.P., general manager, presided over a gathering of about 200, representative of every phase of the concern's activities. The chairman was supported by Mr. F. L. Burder, chairman of the company; Mr. C. M. Brown, secretary and voting partner; Dr. H. H. Brown, Mr. R. Coningsby Clarke and Mr. H. E. White, voting partners, and by the departmental managers.

The loyal toast having been honoured, the chairman reviewed the position of the company during the past year. He remarked that they had suffered from the general depression in practically every branch. Referring to world causes generally and their effect on trade, Mr. Pate declared that something was surely wrong when baths, pig-iron, etc., were dumped into this country while British workmen drew unemployment benefit.

The toast of the evening, "Carron Company," was proposed by Mr. J. George, cooking and gas manager, who referred to the spirit in which the pioneers of the company had overcome almost insurmountable difficulties and how the various crises in its history had been met. The company was again passing through a critical period, and he asked his colleagues to uphold the traditions which had been handed down to them and to maintain their prosperity.

Mr. F. L. Burder, in reply, dealt with the various activities of the company, and drew attention to their manufacturing facilities. In thanking the staffs for their loyalty he asked for its continuance, without which the company's efforts would be in vain.

Mr. J. Laird, chief electrical engineer, proposed the health of the chairman, which was enthusiastically pledged. Mr. George Pate in response paid tribute to all who had contributed to the enjoyment of the evening. An excellent musical programme was provided, and the evening was concluded with the singing of "Auld Lang Syne."

Sand *versus* Loam Moulding.

At the January meeting of the Junior Section of the Lancashire Branch of the Institute of British Foundrymen, Mr. A. Sutcliffe gave a practical Paper on "Sand *versus* Loam Moulding." Mr. H. V. Grundy was in the chair.

Mr. Sutcliffe dealt with the type of work encountered in jobbing shops, which could either be made by loam strickling or in sand by sections of patterns. He pointed out that the cost was the primary consideration. In the case of a "one-off" job, the cost of making a pattern prohibited the use of sand moulding. He illustrated by diagrams and slides how a job could be carried out in loam and also in sand, and indicated which was the cheaper method. He successfully combined the two methods in certain instances.

The lecturer was heartily thanked for his Paper, and the chairman announced that the Section proposed holding a social and dance, the provisional date of which was March 14.

The County of London Electric Supply Company have placed a contract with Messrs. Babcock & Wilcox, Limited, for boiler plant for the Barking power station in connection with the Electricity Board's grid scheme. This is probably the largest boiler plant ever ordered in this country at one time. Its value runs into nearly £700,000. With the contracts which Messrs. Babcock & Wilcox, Limited, have in hand at the present time, their works at Renfrew, Dumbarton, Lincoln and Oldbury will be kept fully occupied for some time to come.

Random Shots.

One of the few industries which shows no sign of depression in these times is the preparation of fried fish and chips. The trade has grown to such an extent that some cities have scheduled it as an obnoxious trade, and the City Fathers require to be asked for a formal permit before they will allow it to be carried on. Which reminds me of a story told about a very august ex-Minister, now over 80, the Rt. Hon. Augustine Birrell, whose verbal felicities earned such admiration that particularly clever writing or speaking came to be known as "birrelling."

* * *

He once caught a suburban train by the skin of his teeth, jumped hastily into a third-class carriage and sat down heavily next to a small girl in shawl and clogs, out of breath from his effort. The small girl seemed rather concerned about something, and seemed to regard Birrell with marked disfavour. It gradually dawned on him that he was sitting on her newspaper, so he immediately drew this from under him and returned it with his apologies. Even this didn't appear to satisfy her, but she said nothing until they reached the next station, when she got up to get out. She turned timidly and asked: "Please, sir, may I have my fried fish and chips as well?"

* * *

Fashion note. A dress expert says that with long evening frocks long hair is becoming. Becoming what?

* * *

A carpenter and joiner paid his first visit to a football match, and it so happened that the home side defenders had nothing to do, the bulk of the game being in the visitors' half. The home goalie took it easy between the posts, and lounged against them with the air of a man of leisure. The carpenter asked his friend many questions as to the goalkeeper's function, but seemed nonplussed that he should have nothing to do. Finally he asked how much the goalkeeper was paid. "Oh," said the friend, "I suppose that with bonus he earns six or eight pounds a week." "Good heavens," said the carpenter, "I would board the whole goal up for thirty bob."

* * *

I hear that the long, round dust-extraction bags on the recently-installed Sesci furnace in the North have been christened by the men "Cissie's Stockings." But, then, even a Belgian would have some difficulty in pronouncing Sesci.

* * *

The past weeks have provided the usual very ponderous and long speeches from the various chairmen of the leading banks. It is interesting to see no less an authority than Mr. McKenna going over to the theory that we can under some circumstances save too much. There is an idea that banks are temples of savings and bankers high priests of thrift. As a matter of fact, the really profitable part of a bank's business is lending money, and when industry is dead there is nobody to lend it to, and hence no interest to earn.

* * *

Business men who have had to be content to make losses for a few years will smile rather grimly at the remark that, in spite of the depression, the bank would pay the same dividend as it had paid for umpteen years. Banking, like food, tobacco and brewing, seems incapable of being touched by depression in any real sense. I have no share in these activities.

Marksman.

Presentation to Ex-Bailie John King.

The National Light Castings' Association and the Light Castings Ironfounders' Federation having been superseded by the British Ironfounders' Association, the members of the former associations were unanimous in the desire that their appreciation of the work of their chairman, Ex-Bailie J. King, J.P., should be reognised in some tangible form. Thus, on January 28, a luncheon party was staged at the Grosvenor Restaurant, Glasgow, under the chairmanship of Mr. George Pate, of the Carron Company. He was supported by Mr. W. Mathieson (Wilsons & Mathiesons, Limited), Captain Kennard (Falkirk Iron Company), Mr. George Scotland (Falkirk Iron Company), Mr. W. Rennie (D. King & Son), Mr. C. W. Dawson (Newton, Chambers & Company, Limited), Mr. N. M. Brown (Lion Foundry, Limited), Mr. John Cameron, J.P. (Past-President of the Institute of British Foundrymen), Mr. V. C. Faulkner (Past-President of the Institute of British Foundrymen), Mr. T. P. Cameron (Cameron & Roberton), Mr. A. D. MacKenzie (MacKenzie & Moncur), Mr. J. M. Primrose (Grangemouth Iron Company), Mr. D. Sharpe (Foundry Plant & Equipment Company), Mr. W. R. Blair (Director of the British Ironfounders' Association) and Commander Withers (Birmingham Manager, B.I.A.).

EX-BAILIE JOHN KING, J.P.

The CHAIRMAN said that the gathering indicated the respect, esteem and gratitude for all that Mr. King had done for them individually and collectively for so many years and the outstanding services he had rendered to the light-castings industry. They were marking that day the occasion of the going ashore of their trusted pilot, Mr. King, whose sound judgment and skilful seamanship had time and again escaped disaster on the rocks. He then called on Mr. Mathieson to present to their guest an illuminated address and a silver tea and coffee service.

MR. MATHIESON first quoted from the official address, which read: "With admiration and thankfulness we remember your great business ability, tact, patience and devotion to the best interests of the light-castings industry, which contributed so largely to the successful formation and operation of the Association and Federation."

Mr. Mathieson said that at the inception of the Association some nineteen years ago, it was his privilege to convey to Mr. King the thanks of the N.L.C.A. and present to him tokens of appreciation of work done prior to that time. That day they had the same object in view, namely, to convey to Mr. King their appreciation for a further nineteen years of continuous and arduous service.

MR. KING, in the course of his reply, referred to the conditions which existed in the industry prior to 1910 and the subsequent developments which culminated in the founding of the N.L.C.A., after which they ceased to regard their neighbours with suspicion and instead consulted with one another. They realised their mutuality of interests, and from this began the cementing together of their section of the foundry industry. Whatever they did in the British Ironfounders' Association, he appealed to them never to act in a niggardly fashion, but be mindful of the interest of their neighbours. Thus they would be doing the best for their country, for the Association and themselves. Finally, he thanked them most sincerely for their good wishes and what they had presented to him.

The American Foundrymen's Association's 1931 Convention.

Additional exhibit space, provision for several new sessions, a broader programme of Papers, excellent meeting-room facilities, and all Convention activities housed under one roof—these are features of the 1931 Convention of the American Foundrymen's Association, which is to be held from May 4 to 7 in Chicago. In addition, many important plants in the Chicago district, which is one of the main foundry centres in the country, will be open for inspection throughout the four days of the meeting. Fifty per cent. more exhibit space has been provided this year than was available at the 1929 Chicago meeting. Space applications have been posted, and assignments of space will begin in the near future.

Preliminary plans for the programme of the Convention have been well worked out by an extensive committee which assures that the Papers and reports presented will be of a quality and interest not exceeded at any previous annual meeting. Some new features have been added and Papers have been promised on particularly interesting new developments in the foundry industry.

One new feature of the Chicago meeting will be the session on problems relating to pattern-making. The increasing attention being directed to pattern production and procedure by foundrymen led to the initiation of this session, and it is fully expected that its reception will be such as to assure the holding of similar sessions at future conventions of the American Foundrymen's Association.

Shop-Operation Courses.

Another innovation of the 1931 programme will be the shop-operation course on sand control. This phase will consist of a three-period instructional course for those who seek information on how to instal a sand-control department. Another new shop-operating course, dealing with malleable-foundry practice, will also be held this year. These shop-operation courses, numbering five this year, will be arranged to give instruction in the fundamentals of grey iron, steel, non-ferrous and malleable founding, and in sand control. Committees have been formed to arrange the schedule of each course.

Round-table luncheon meetings have been scheduled for the malleable, steel and non-ferrous groups. The steel-castings conference will be presided over by Mr. H. P. Evans, metallurgist of the Hubbard Steel Foundry Division of the Continental Roll & Steel Foundry Company, East Chicago, Ind. The vice-chairman of this meeting will be Mr. F. J. Stanley, general manager of the Michigan Steel Castings Company, Detroit.

The chairman for the non-ferrous group will be Mr. H. F. Seifert, superintendent of the brass foundry of the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa. Mr. Seigert will be assisted by Mr. F. L. Wolf, technical superintendent of the Ohio Brass Company, Mansfield, Ohio.

Sessions of general interest which have been tentatively scheduled include those on foundry costs, pattern production, sand research and apprentice training. Any or all of these sessions will have much to offer in the way of value to all who attend the Convention. Two cost sessions will be held, one on general foundry costs to discuss methods of figuring moulding costs and data which the purchaser should furnish when requesting bids. The second cost session will be devoted entirely to non-ferrous foundry costs.

The committees which are now organising the sessions on metallurgical and production phases of the various branches of the foundry industry have secured a number of worth-while Papers. These Papers will form the basis for three sessions on grey iron, two sessions on non-ferrous castings, two on steel castings and one on malleable founding. Mr. V. C. Faulkner, a Past-President of the Institute of British Foundrymen, is presenting the official Exchange Paper on behalf of that body.

Tentative Programme.

A tentative schedule of meetings and events for the Convention is given below:—

Monday, May 4.—Morning: Registration; business meetings; opening of foundry equipment exhibit.

Tuesday, May 5.—Morning: Sand-control shop-operation course (1st session); grey iron founding; malleable founding; pattern production, and non-ferrous foundry costs. *Afternoon:* Malleable founding round-table luncheon; foundry costs; shop-operation courses: steel, malleable, grey iron, non-ferrous (1st session).

Wednesday, May 6.—Morning: Sand-control shop-operation course (2nd session); grey iron founding; non-ferrous founding, and steel founding. *Afternoon:* Steel founding round-table luncheon, non-ferrous founding round-table luncheon; sand research; apprentice training, and shop-operation courses: steel, malleable, grey iron, non-ferrous (2nd session). *Evening:* Annual banquet.

Thursday, May 7.—Morning: Sand-control shop-operation course (3rd session); grey iron founding; non-ferrous founding, and steel founding. *Afternoon:* Annual business meeting and special lecture; shop-operation courses: steel, malleable, grey iron, non-ferrous.

Contracts Open.

Bangalore, Mysore, February 6.—Three miles of 24-in. spigot and socket steel pipes, for the Government of Mysore. Messrs. Rendel, Palmer & Tritton, consulting engineers, 55, Broadway, Westminster, S.W.1. (Fee 7s. 6d., non-returnable.)

Gainsborough, February 9.—Cast-iron pipes, for the Urban District Council. Mr. S. W. Parker, engineer and surveyor, Gainsborough.

Holywell, February 12.—Pumping station and plant with 35 miles of mains, etc., for the Rural District Council. Mr. R. Jones, clerk, Halkyn Road, Holywell. (Fee £5 5s., returnable.)

Iquique, March 10.—Three travelling cranes, for the Port Works Department of the Chilean Ministry of Marine. The Department of Overseas Trade. (Reference A.X. 10,740.)

Manchester, February 10.—Iron and steel stores, for the Corporation. The General Manager, Corporation Transport Department, 55, Piccadilly, Manchester.

Settle, February 9.—1,100 yds. of spun-iron pipes, etc., for the Settle Rural District Council. Mr. F. J. Rodwell, engineer, 37 and 38, Prudential Buildings, Park Row, Leeds. (Fee £2 2s., returnable.)

Wolverhampton, February 8.—12,200 yds. of cast-iron pipes, etc., for the Corporation. Mr. B. L. McMillan, water engineer and manager, Town Hall, Wolverhampton.

XUM

Cupola Malleable Cast Iron.

By H. H. Shepherd.

(*Continued from page* 84.)

Box Equipment.

Since the greater portion of pipe fittings required is comparatively small in size and weight, the use of snap flasks becomes most efficient and economical in every way, and this is the general practice in the foundry with which the author is associated. Moulding boxes are used in the making of larger fittings or special castings only. As will be realised, if snap flasks are used, pouring jackets will be necessary in most cases to surround the mould whilst casting, so as to prevent breaking or bursting away of the mould at the side. Very often sheet steel is used for this purpose, but as such jackets are apt to get buckled with continual use, cast-iron jackets are used. These are perforated in such a way as to permit rapid escape of the gases. Each bay of moulds will have about half a dozen of these jackets, so that half a dozen or so moulds are poured, and then the jackets are removed to other moulds, and so on.

All moulds are supported on bottom boards, and after pouring are tipped on to a conveyor, which carries the sand and castings to a unit where the sand separates from the castings and is elevated to the sand-treatment plant, while the castings pass to the cleaning and sorting division. Sand is fed to each machine from overhead hoppers, which supply the system sand, or what is more commonly known as "black" or "floor" sand. Facing sand is supplied to each moulder from the facing-sand mill in barrow loads, and this is the only material that the moulder has to use a shovel for.

Moulding Sands.

The subject of moulding sands is one which, like all other branches of the foundry, has been sadly neglected and, as a result, little was known of the true requirements and properties of a moulding sand until a few years ago. This was due largely to the fact that we, as a nation, were favoured in being possessed of sands in almost any part of the country which were very suitable for moulding purposes, and which became famous the world over on account of their suitability. There were then enormous deposits of these sands, which at that time, and even to-day in some cases, were of such a character as to make them eminently suitable without much blending or attention for foundry work. "Familiarity breeds contempt," and so the tendency was for moulding sands to be regarded as material that would always be naturally good or suitable for the job, and, apart from rule-of-thumb tests as to whether a sand had sufficient bond or not, little other attention was paid to it. On the other hand, the U.S.A. were not particularly well-favoured in supplies of natural sands of which the properties were suited to moulding requirements, and they were to some extent forced to probe the sand question very deeply. It is for this reason that synthetic sand has received so much attention in the States. The sand problem was given attention in U.S.A. long before we, in this country, started to think seriously and scientifically about the matter, and everyone will agree that the Americans are entitled to every credit for the very earnest way they set themselves out to deal with the study of sands, and also for the enormous amount of work they have done and the results achieved. The writer feels that he must at this stage point out that one of the leading pioneers, probably *the* leading pioneer, in the study of the sand problem in U.S.A.—E. W. Smith, at present associated with Crane Company, of Chicago—who undoubtedly is recognised in the U.S.A. as the "Grand Old Man" of sands. Mr. Smith's views are that more defects in castings are caused by sand than by anything else, and the writer feels that foundrymen will agree that this is so to a very great extent. How often has one heard the moulder being blamed, the metal being blamed and almost everything but the sand, and if the old-time moulder raised a protest against the sand in many shops, well—he was just wrong.

Although, until a few years ago, Britain was behindhand in the study of moulding sands, it must not be forgotten that sand, as a subject, had been tackled by a few private investigators some years before it was tackled officially, among the most prominent of these investigators being Prof. Boswell, whose works on sands for all purposes form extremely valuable treatise, and are the foundations upon which sand study in this country has been built. Rapid strides have been made on the subject during the last 10 years,

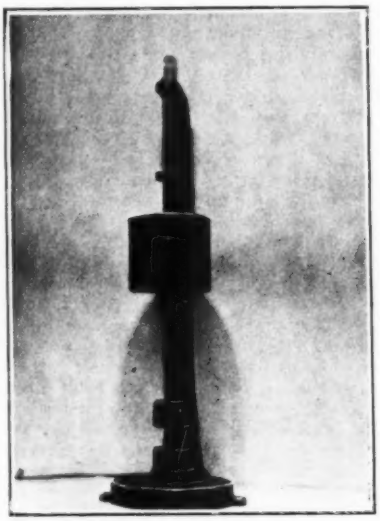


Fig. 4.—Standard Rammer of Sand Permeability Apparatus.

and, as a result of the very energetic efforts and very valuable work of the B.C.I.R.A., national knowledge of sands can be, if we set ourselves out to learn and practise the findings of the Association's work, not far behind—if at all—that of the U.S.A. The one great difference as yet is that the American foundrymen have applied their knowledge obtained to actual practice to a far greater extent than British foundrymen have of the knowledge now available in this country.

At this point the author would mention, that whilst the apparatus and methods used in his laboratory for the testing of sand are those similar to, or as, set forth and recommended by the Committee on Moulding Sand Research of the American Foundrymen's Association. This is not because of any bias or discredit of the methods or apparatus recommended by the B.C.I.R.A., but because by the use of such apparatus it is easier to interchange information and make comparisons with companies associated with the Crane-Bennett organisation, particularly the Montreal factories. Until the completion of extensive enlargements to the Nacton factory, the staff is operating in a temporary laboratory, and the necessity for curtailing some of the sand tests will, therefore, be understood, but in the near future it is hoped to equip a sand-testing laboratory with all apparatus necessary to maintain higher efficiency of sand control, and such equipment will include that of the B.C.I.R.A. in order that the staff can keep in close touch with the Association on sand problems.

Sands Used.

In general, the sands found satisfactory for cast-iron work may be used for malleable, but the author prefers to use much more open sands than those used for grey iron. Such sands will permit rapid escape of the gases, which is a direct advantage when dealing with a comparatively short cooling-range metal. Sand which is too close is apt to cause "blows." Further, a comparatively open sand can be rammed much harder than may be usual, which is again an advantage in snap-flask work, as the mould will stand handling better. At one time Erith sands were used, but it was found that the amount of "fines" and silt in the sand, plus the "fines" or silt created as a result of the use of the sand, became so excessive as to cause serious trouble, and the use of this type of sand had to be abandoned. Resort was made to the Worcestershire red type, but even this grade of sand was too fine for much of our work, and later the coarser grade of Worksop sands were adopted, with sometimes the addition of small quantities of a strong sand of the Yorkshire type to obtain the necessary bond.

As a result of experience with these various sands, the author has a very favourable attitude towards the red sands for the manufacture of malleable castings, one reason being that the bond of the red sands has a greater life than that of the sands where the bond is natural, due to clay. In red sands a good proportion of the bond is due to iron oxide of a particular form which is more resistant to heat than ordinary clay or mobile bond. The bond strength of the sand must be controlled carefully—a medium bond is required; if too strong, excessive strains and often cracks will develop in the castings. The bond is partially dependent on the openness or permeability of the sand, and also, of course, on the moisture present and the time and condition of milling operations. Five minutes is approximately the normal milling time for facing-sand mixtures. The moisture content of the sand must be carefully controlled; excess of moisture will lead to many troubles, among them being short runs, blows and shrinks. With the particular sand mixtures used in the writer's firm, the moisture content is kept under 5 per cent. and preferably nearer 4 per cent. The quantities of coal dust added also require close control. Too great an amount, if used for any length of time, will result in, among other things, a serious decrease in the permeability of the sand, the ash from the coal dust acting in a very similar manner to silt in a sand. Further, too great a quantity will result in "cold-shut" castings, a dangerous defect if present in pipe fittings. Very often "cold shuts" appear like, and are mistaken for, short runs due to cold metal or bad pouring, and only the keen observer will detect the difference. A short-run casting will have rounded edges where the metal ends. In a "cold shut" not due to cold metal or pouring, but possibly due to excessive coal dust, one of the edges of the metal will be found as in short runs, while the other edge will run up to it and even envelop it to form quite a sharp fin, proving that in such cases it is not due to cold metal. The amount of coal dust that may be safely used will, of course, depend upon the particular type of castings made and facing-sand mixtures used. For small castings it may be approximately 7.0 per cent.

Control Tests of Sands Used.

Daily tests on the facing and system—or box—sands involve moisture, bond-strength and permeability determinations. Periodically, sieve-

fineness tests are made, using a set of sieves 20, 40, 60, 80, 100, 150 and 200. Whilst the objections to the original sieve tests on the dry sands are well appreciated, this non-standard test has proved a valuable and rapid means of detecting increases in the fines and silt of the sand, and it was, in fact, the means by which the excessive fines increase in the system sand was traced to the use of Erith sands, but the author would emphasise that it is not in any way given as a standard test. The determination of moisture is carried out in the usual way—that of weighing a quantity of sand before and after drying at a temperature of 105 to 110 deg. C. for a period of time.

Permeability.

This is determined by an apparatus similar in principle to that recommended by the A.F.A., but in design it is simpler and more robust than the standard apparatus. It is also easier to operate and does not have the disadvantages that one is apt to meet in regard to the stopping out of the orifices on the standard apparatus, which is very apt to occur, and also these orifices are easily scratched by small particles of sand. The apparatus the author uses gives results which check closely with the standard apparatus. Further, it possesses the advantage

FIG. 5.—THE AYERS PERMEABILITY APPARATUS.

of rapidity, a big factor in the routine testing of sands.

The instrument is known as the Ayers Mineral Company Permeability Apparatus. The specimen for permeability test is prepared by a standard apparatus which comprises of a brass tube to form and carry the sand specimen and a standard ramming arrangement. A sufficient quantity of sand is taken to make a column of sand when rammed 2 in. (5.08 cm.) in height and 2 in. diameter with a tolerance of plus or minus 4 per cent. or ¼ in. on the height of the specimen. To form the specimen the sand is carefully loaded into the brass container, which is stood on the loose pedestal from the ramming apparatus, levelled off, and the cylinder containing the sand is placed in position on the rammer. The standard rammer (Fig. 4) consists of a cast-iron frame, which carries a steel rod supported by two guides on the frame. To the lower end of the rod is fitted a steel rammer head, which just fits freely into the brass cylinder. A cylindrical iron casting of standard weight (14 lbs.), bored through the centre so as to slide up and down the steel rod; the movement is limited by two stops to 2 in. On the top of the frame is a scale with three markings on it. This indicates the minimum and maximum tolerances. When the container is placed in position on the base of the rammer, the rammer head is gently lowered so that the head and rammer are supported by the sand, the rammer is next raised carefully to the upper stop, care being taken to avoid movement of the steel rod. It is then allowed to fall by sharply withdrawing the hands. The operation is twice repeated. If, after ramming the top of the upper end of the steel rod sides off within the tolerance marks, the rammer head is lifted to allow withdrawal of the tube containing the sand specimen. Into one end of the tube is fitted a rubber stop carrying a small brass-tube connector, and by this the container is connected to the permeability apparatus, as shown in the illustration. The permeability equals the number of c.c. of air drawn through the specimen × the height of the specimen and the product of this divided by the product of the pressure in grammes × the area of the specimen × the time in minutes, or decimals of a minute. Since the volume of air is constant which is drawn through, and also the size of the specimen, then the formula becomes

$$\frac{125.3}{\text{T.P.}}$$

The Ayers Permeability Apparatus (Fig. 5) consists of a large brass reservoir, which can be filled with water by a rubber tube attached to the base of the cylinder and to a water tap. The level of the water is indicated on the glass gauge at the side of the reservoir, and this is marked off into two divisions. There is also fitted at the bottom of the reservoir an adjustable discharge tube by which the pressure at which it is desired to make the test can be set by moving the tube up or down. At the top of the reservoir are two stop-cocks, the one of the left being connected to a "T" piece, which in turn connects with the brass cylinder containing the specimen and also with the manometer.

To make the test, the tube containing the specimen is connected as shown in Fig. 5, the left-hand stop-cock is closed and the right-hand one opened. The water supply is then turned on and the end of the discharge tube closed by the thumb or finger. The reservoir is thus allowed to fill slowly to the top mark on the water gauge. The water is then shut off and the left-hand valve opened; this will then cause a vacuum pressure to be registered, which is adjusted by movement of the discharge tube until the manometer water level is exactly on one of the pressure lines. The discharge screw is then tightened and the left-hand stop-cock closed again, the water level in the reservoir readjusted. Then the left-hand stop-cock is opened quickly and, at the same time, a stop-watch is started and the time required for the level of the water in the gauge to drop from the top mark to the middle mark is noted. The permeability is then calculated by the time taken in minutes, or tenths of a minute, by the pressure used, and the product divided into 125.3, the constant for this apparatus, since 500 c.c. is the volume of water drawn through the specimen, and this × 5.08 (2 in.), the height of the specimen, divided into 20.268 sq. cm., the area of the specimen = 125.3. For very open sands a pressure of 1 to 2 cm. is used, whilst for close sand it may be 20 or more; as high a pressure as possible is used, but not so high as to cause a test time of less than 20 sec. or 0.33 min. The zero on the manometer must always be checked. The test can be made in 2 to 3 min., and a chart is supplied with the instrument by which it is possible to obtain the permeability without calculation.

The author endeavours to maintain a permeability of 40 to 50 in the sands used. It should be borne in mind that the permeability figures obtained on this, or the standard A.F.A. apparatus, are the opposite in meaning to those obtained on the B.C.I.R.A. apparatus—that is, the higher the figure obtained by the A.F.A. method, the higher the permeability. With the B.C.I.R.A. method, the higher the figure obtained the lower the permeability.

Compression Strength.

This test forms a means of determining the green-bond strength of sands. The machine used for this purpose is known as the "Adams" Compression Apparatus (Fig. 6), and briefly may be described as consisting of a steelyard which is balanced by a moving fulcrum operated on a screwed rod through a small handwheel. At the wheel end is the balance weight, and, at the other end, is the specimen carrier which is attached to the steelyard through a pantograph frame which possesses a knife edge. Through the table of the machine is projected a short rod which fits loosely into a hole in the movable steel specimen carrier. In the crosshead of the machine is a plate attached to a screwed small rod, so that it can be lowered on the specimen at the beginning and during the test to ensure the steelyard being kept level, which is indicated by a small spirit level attached to the steelyard.

To make the test—after forming and ramming the specimen—is exactly the same as for the permeability test. The specimen of sand is stripped from the brass container by a wood stripping post, carrying a dowel projection, which will fit into the hole in the base of the steel specimen carrier, the carrier being set on the stripping post, and then the tube containing the specimen is slid over this, and a continual downward pressure pushes out the sand specimen on the carrier. They are set on the machine, the levelling plate screwed down until the steel yard is level, and the handwheel operated, causing the

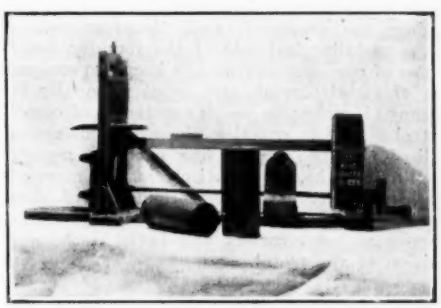


FIG. 6.—COMPRESSION APPARATUS FOR DETERMINING GREEN-BOND STRENGTH OF SANDS.

fulcrum to traverse the screwed rod and by leverage effect exerting a pressure on the specimen until it breaks. At the moment of collapse of the sand, turning is stopped, and the breaking load, which is marked off in pounds per sq. in. of sand, is read off. This is a measure of the green-bond strength of the sand. Sands up to 30 lbs. per sq. in. may be tested on this machine. For the various sand mixtures used, compression strengths from 7 to 10 lbs. per sq. in., according to requirements, are obtained.

Before leaving the question of sands, it may be worth while mentioning an example of the effect of milling upon the bond strength and permeability of a moulding sand, and the following figures are given to illustrate this:—

Before Milling.—Moisture, 3.9 per cent.; compression bond strength, 6 lbs. per sq. in.; and permeability, 54.

After Milling for Four Minutes.—Moisture, 3.6 per cent.; compression bond strength, 10.5 lbs. per sq. in.; and permeability, 42.

Metal Composition.

The chemical composition of metal for the production of cupola malleable has to be very carefully controlled. Without undue criticism of white-heart malleable, it can be stated that the variations of composition in the case of metal for white-heart can be very considerable, and yet the annealed product still result in a malleable casting. This has been proved to the writer's satisfaction by the examination and the close contact from time to time which he has had with testing and manufacturing white-heart malleable

D

iron. In not a few cases the silicon content varies by as much as 100 per cent. for the same size and type of casting. Further, the author has analysed good white-heart malleable castings containing over 0.4 per cent. sulphur and exceptionally low manganese—less than 0.15 per cent. These castings were made some 30 years ago.

Such large possible variations in the composition for white-heart do not, of course, result in a product having uniform physical properties. It is a fact that white-heart annealing practice will cover up a lot of sins in regard to non-uniformity of metal composition or even erratic cupola practice. Again, the author does not wish to convey the impression that, because of these large possible variations, all white-heart makers are content to operate in a careless or rule-of-thumb way. The progressive malleable founder realises that the more uniform his metal composition is, the more uniform will be the result of annealing and the more uniform and reliable the final product.

However, in the case of black-heart malleable, the permissible variations for most of the elements present are very small. If they are exceeded, the metal will not anneal at all, and the presence of such material is soon felt by the machine shop, since taps and dies have their threads broken as soon as tapping or threading is started. To the customer, this is an advantage, since it practically ensures him against getting any castings which have not annealed satisfactorily, but to the manufacturer it becomes a very expensive item if many of such castings are produced, and, therefore, control of the metallurgical side of the foundry has to be one of constant alertness to keep the composition of metal correct, and, what is equally important—if not more so—is constant and correct control of cupola practice, since it is, of course, realised that, no matter how excellent a metal mixture may be, it is entirely at the mercy of cupola practice. As in the production of black-heart malleable by air furnace, the annealing practice will not correct any fault in the composition of the metal.

Total Carbon.

This should be as low as is possible to produce good fluid iron, but preferably not below 3 per cent., since iron having lower total carbon combined with the comparatively low silicon and high sulphur, and produced by ordinary cupola-melting practice, will give rise to running difficulties and also unsoundness. On the other hand, high carbon will not produce a good tough malleable casting after anneal. High total carbon affects the tensile strength and elongation considerably, these properties being decreased on account of increase in the number of temper-carbon nodules, which break up the continuity of the ferrite grains. The total carbon should be between 3 and 3.3 per cent. Again, excess total carbon is very liable to give rise to primary graphite formations, especially in heavy sections, but if the carbon is low—in the neighbourhood of 3 per cent.—it is possible to produce iron free from primary graphite in sections of ¾ in. thickness, with a silicon content of about 0.74 per cent. On the other hand, with high carbon, round 3.4 to 3.5 per cent. primary graphite is very liable to form, even if silicon is low—about 0.7 per cent.

From what has been stated, it is plain that the essential points to bear in mind are that total carbon must be reasonably low, and to bear an inverse relation to the silicon content. It is, of course, recognised that other factors affect the content of the carbon in the casting, such as rate of cooling, temperature of casting, section of castings, etc.

Silicon.

It has been stated that the carbon content should vary inversely as the silicon but, as the total carbon is more or less constant for a given cupola practice, then it will follow that, other conditions being equal, there must be an almost constant silicon content, which balances this amount of carbon to give the best results in the castings. Particularly is this so in the annealing practice as regards strength of malleability of the product. If this constant varies greatly, there will arise difficulty in annealing or difficulty in securing freedom from primary graphite depending upon whether the silicon be appreciably lower or higher than the correct quantity. L. E. Gilmore* has put forward a carbon-silicon ratio formula by which the percentage of silicon required to balance a known carbon content can be obtained. The formula is that "Per cent. silicon = 1.5 minus per cent. carbon ÷ 4." Assuming a carbon content of 3 per cent., then the silicon should be $\frac{3}{4} = 0.75$ and $1.5 - 0.75 = 0.75$ per cent. silicon. Should the carbon be 3.3 per cent. then the silicon should be $\frac{3.3}{4} =$ 0.82 and 1.5 per cent. = 0.82 = 0.68 per cent. silicon. Gilmore's formula is of considerable practical value, but in order to apply the black-heart type malleable as produced by the cupola, the author has found it necessary to modify it to some extent on account of the higher sulphur present than is the case of air-furnace malleable. The modification is that 1.55 per cent. is taken as the constant instead of 1.5 per cent. On this basis, a 3 per cent. carbon metal will require 0.8 per cent. silicon and a 3.3 per cent. carbon 0.73 per cent. silicon. It will be noticed that the maximum difference between the silicon required for 3 per cent. and 3.3 per cent. total carbon is only 0.07 per cent., and, whilst this difference may be exceeded in practice, the amounts of other elements are standard. The variation between the maximum and minimum contents cannot safely exceed 0.1 per cent. It can be definitely stated that metal containing less than 0.7 per cent. silicon will not anneal satisfactorily by an annealing practice which gives good results for the correct silicon contents. Further, very low silicon is liable to cause cracks in the castings due to the greater contraction set up, and this trouble is emphasised if the manganese be low also. On the other hand, metal in which the silicon exceeds the maximum that can be balanced by the carbon is very likely to contain primary graphite. It will therefore be realised that it is necessary to control the silicon contents to a very fine limit; in other words, to control the carbon-silicon ratio.

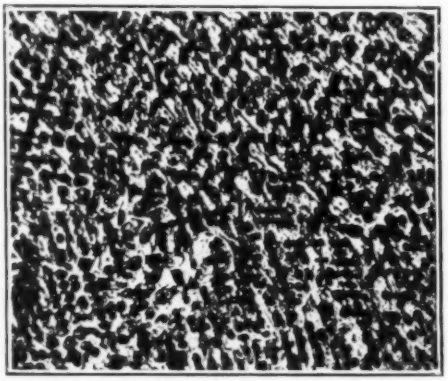


FIG. 7.—"AS-CAST" STRUCTURE OF CUPOLA MALLEABLE CAST IRON (3.3 PER CENT. T.C.).

Sulphur.

The sulphur contents of cupola malleable iron will undoubtedly be very much higher than that of air-furnace malleable. It cannot, however, be permitted to reach as high a figure as is often the case in white-heart malleable. As is well known, sulphur retards graphitisation. Such effect may be helpful in white-heart, but is the reverse of what is required for the production of black-heart type malleable. Therefore sulphur must be kept as low as possible. The maximum figure for cupola malleable is 0.2 per cent.

Manganese.

It is essential that the sulphur be balanced by manganese, and it is recognised that the theoretical requirements are not sufficient for air-furnace malleable, and the same applies to cupola metal. Gilmore found that the manganese content should be at least equal to twice the sulphur content, but great care is necessary to avoid the manganese greatly exceeding the required quantity, as excess manganese seriously retards graphitisation. In regard to the amount of manganese sulphide resulting from the combination of the sulphur and manganese, some authorities state that manganese sulphide has no serious effect upon graphitisation, but the writer is inclined to the view that excess manganese sulphide retards the second stage of graphitisation, whilst undoubtedly excess of this combine will reduce the mechanical properties of the metal.

Phosphorus.

With the types of raw materials used there is rarely any difficulty in keeping phosphorus within the desired limits. It is usual to regard the maximum of these limits to be 0.2 per cent. when considering air-furnace malleable but, in the case of cupola-malleable, it is better to regard 0.15 per cent. as the maximum on account of the high sulphur and manganese content of the metal. Phosphorus has been found to retard graphitisation both of the first and second stages in a manner similar to manganese and sulphur. Quite a considerable amount of the product under the author's control is required to be hot-galvanised, and there is a danger of brittleness arising on galvanising if the phosphorus content exceeds 0.15 per cent.

Chromium.

The effects of chromium on the annealing of any black-heart type malleable are very powerful. Small quantities in the nature of a few tenths of 1 per cent. retard graphitisation to a great extent and also are likely to give rise to cracked castings. The maximum figure permissible is 0.03 per cent. In connection with the study of the effects of the common elements upon malleable cast iron, particularly black-heart malleable, the author would strongly recommend those who are concerned with the production of such product to study the work made on the subject by the Japanese investigator, Tario Kikuta, of the Research Laboratory of the Tobato Foundry, Japan. The account of this work was published in THE FOUNDRY TRADE JOURNAL.* This work is, in the writer's opinion, an extremely valuable study on "The Malleable Cast Iron and the Mechanism of its Graphitisation"—the title of the Paper.

The Structure of the Metal.

The structure of air-furnace malleable in the hard condition consists of approximately 75 per cent. of pearlite and 25 per cent. of free cementite, but cupola malleable has an "as-cast" or "hard" structure which, though somewhat similar, differs in the amounts of pearlite and cementite it contains, these being in the approximate proportions of 60 per cent. of pearlite and 40 per cent. cementite which varies with the carbon of the metal. A 3.3 per cent. T.C. assumed to be all in the combined state will give a structure consisting of about 42 per cent. of cementite and 58 per cent. pearlite, which contains 4.3 per cent. of carbon and consists of cementite and pearlite. This structure is shown in Fig. 7.

Whilst carbon content is the primary factor affecting the amount of cementite present and

(*Continued on page* 109.)

* "Carbon - Silicon Ratio." L. E. Gilmore, "The Foundry," July 1, 1928, pages 529 and 531.

* FOUNDRY TRADE JOURNAL, November 11, 25 and December 2, 1924.

Progress in Metallurgical Research.

By C. H. Desch, F.R.S. (Professor of Metallurgy in the University of Sheffield).

The Iron and Steel Industrial Research Council, the formation of which was recorded last year, now has a definite programme of work in hand, and has made itself responsible for the two committees originally set up by the Iron and Steel Institute, dealing with the heterogeneity of ingots and with corrosion. The Ingot Committee has, during the last year, prepared a number of ingots under carefully-controlled conditions, partly in works and partly in the experimental furnace at the University of Sheffield, and the discussion of the structures revealed by them will form the basis of next Report.

Independently of this work, but with a very definite bearing upon it, a description was given to the Iron and Steel Institute at its Autumn Meeting in Prague of an ingot made by the Harmet process of compression during freezing. The Paper by Dr. Kříž shows, by sulphur prints and macro-etching as well as by analysis, how this ingot differs from those which have cooled undisturbed in the mould. It is interesting to observe that whilst, as might be expected, such an ingot is free from pipe, it exhibits segregation in a very similar manner to ordinary ingots, such differences as are seen being in the geometrical arrangement, and not in the amount. Amongst other Papers on ingot subjects, mention should be made of one by Mr. S. Maita, read at the Annual Meeting of the same Institute, dealing with the corner ghosts often found in large ingots. These are shown to be caused by stresses set up during cooling, and the mechanism of their formation has been studied by experiments with steel and also with ice containing suspended colouring matter, the distribution of which reveals the boundaries of the columnar crystals.

Blast-Furnace Reactions.

A very striking Paper was communicated to the same meeting by Prof. W. A. Bone and Messrs. L. Reeve and H. L. Saunders, on the interaction of gases and ore in the blast furnace. The authors had previously shown that at comparatively low temperatures the deposition of solid carbon by such reactions is of great importance, and this aspect has now been examined in detail. A remarkable laboratory experiment consisted in exposing a fragment of Cumberland hematite at 450 deg. C. to the action of blast-furnace gas. The deposition of carbon took place in the mass of the ore, which increased in weight twenty times, while expanding and retaining traces of its original shape, so that at the end of the operation the distribution was so uniform that any fragment of the solid taken, was found to consist partly of iron. It is easy to see that this impregnation of solid ores by carbon must play an important part in the reactions of the blast furnace. In the early, but extraordinarily thorough, work of Sir Lowthian Bell, this reaction was found to be at a maximum at 450 deg. C.

Ore so impregnated with carbon is readily reduced at a higher temperature, the fine solid carbon in the mass of the ore being a much more powerful reducing agent at 750 deg. C. than gaseous carbon monoxide. It is important to remember, however, that carbon deposition may also take place in another way, the solid carbon forming a more or less impervious layer around the granules of ore. The carbon then hinders the reduction instead of hastening it. The exact conditions determining the form that the carbon will take have yet to be ascertained. That much ore is disintegrated in the course of its passage through the blast furnace is shown by an incident mentioned in the discussion. A slip in a furnace led to the ejection of all the contents down to the bosh level, and the absence of large pieces was specially remarked. After making all allowance for crushing, it was evident that the ore had been largely disintegrated by chemical reactions within its mass.

Behaviour of Steels at High Temperatures.

The progress of both the engineering and the chemical industries has brought about a rapidly-increasing demand for metals capable of resisting high temperatures. Included among such materials are the heat-resisting steels and alloys, which retain a considerable strength at a red or white heat and present a high resistance to oxidation, and also steels which have to sustain high mechanical stresses for long periods without appreciable change of shape, at temperatures which become higher and higher as progress is made in the design of high-pressure boilers and chemical-reaction vessels. Many of the steels used for such purposes are highly alloyed, and as the proportion of alloying metal is increased, the composition approaches more nearly to that of the nichromes and similar alloys, frequently classed as non-ferrous.

The boundary between steels and non-ferrous alloys thus becomes arbitrary, and it is often necessary to examine a range of compositions on both sides of it. This applies to the investigations, also presented to the Iron and Steel Institute, by four of the staff of the National Physical Laboratory, Messrs. C. H. M. Jenkins, H. J. Tapsell, C. R. Austin and W. P. Rees. A very wide range of alloys of iron with nickel, chromium and other metals, such as tungsten, molybdenum or vanadium, was examined in detail at temperatures from 650 deg. to 800 deg. C. The ordinary short-period tensile test at high temperatures is useless for this purpose, as "creep" under prolonged stress does not bear any constant relation to the mechanical properties under static conditions, and it becomes necessary to make endurance tests of a tedious character. It is interesting to find that the firms manufacturing steels of this class had already fixed upon the compositions which give the best results, the only improvement on the best commercial steels being obtained by the use of alloys containing such a large proportion of the more expensive metals as to make the cost very high.

Whilst it must be admitted that a full knowledge of the behaviour of a steel under stress at high temperatures is only to be gained by determining the limiting creep stress at a series of temperatures, such a procedure is exceedingly lengthy, and manufacturers who are called upon to provide a suitable material for a given purpose are faced by the necessity of finding some test which will serve as an approximate guide. Dr. W. H. Hatfield described, at the Prague meeting, such an abbreviated test, found useful for practical purposes, and deserving discussion in the absence of a strictly logical specification. That stress is found which, at the given temperature, produces an elongation not exceeding 0.5 per cent. in the first 24 hrs., and in the next 48 hrs. produces no further change of length when measurements are made such as would detect an elongation of the order of one millionth of an inch per inch per hour. The determination of this "time-yield" only occupies three days. The safe stress is then taken arbitrarily as two-thirds of this limit. Clearly the stress thus calculated has a purely empirical value, but it serves a useful purpose in suggesting the most suitable steel for a given object. Tested in this way, the safe stresses for ordinary steels at temperatures above 500 deg. are surprisingly low. An interesting fact that has emerged from such work is that for many alloys, cast test-pieces creep less when hot than forgings, unless the latter are thoroughly annealed.

Nitrogen in Steel.

The influence of nitrogen on the properties of iron and steel has long been a matter of controversy. The quantity dissolved under ordinary conditions of manufacture is very small, and it is only when some compound of nitrogen, such as ammonia, is allowed to act on the metal that any rapid absorption takes place. This "nitriding" process has now assumed great technical importance, having marked advantages over ordinary case-hardening for many purposes requiring a hard wearing surface. The presence of nitrogen in high-temperature welds has often been noticed, and has recently been investigated by Mr. L. W. Schuster, who confirms the observation that the needle structure frequently seen in such welds is due to nitrogen and to nitrogen only. Mr. C. E. Stromeyer, in numerous Papers and contributions to discussions over many years, urged the view that the development of brittleness in many specimens of mild steel, such as boiler plates, was due to nitrogen, and that the liability to brittleness was directly dependent on the proportion of nitrogen in the steel. This view has now received independent and unexpected confirmation. Dr. W. Köster, of Dortmund, has published a series of Papers in the "Archiv für das Eisenhüttenwesen," which throw a new light on the ageing of steel.

It has long been known that ageing, which takes the form of a decrease of toughness and a deterioration of the magnetic qualities with time, is more pronounced with basic-Bessemer steel than with that made by the open-hearth process, this fact being in accordance with the relative proportions of nitrogen in the different steels. It appears from the work of Köster that the solubility of nitrogen in α-iron at 450 deg. is 0.025 per cent., becoming vanishingly small at atmospheric temperatures. Ageing is a process of age-hardening similar to that known in duralumin and other non-ferrous alloys, brought about by the separation, in ultra-microscopic form, of a constituent from a supersaturated solid solution. The separation of the nitride is exceedingly slow in comparison with that of carbide, and it is possible to examine the two processes in the same specimen in steel on account of their different velocities. The process may be studied by means of the microscope, using the Fry copper solution as an etching reagent. Particles on the limit of microscopic visibility have a considerable influence on the coercive force.

The separation of these particles from solid solution is greatly accelerated by cold-working the steel before heating. This proves to be the explanation of the anomalies noticed in the production of "strain-etching" in mild steels as described by Dr. A. Fry in 1921. Etching with a special copper reagent was then found to develop very perfect Lüders lines when a mild steel was lightly tempered after cold-working, but other workers failed to reproduce the results, and it was found that whilst certain basic steels gave the effect perfectly, it was unobtainable with most acid steels and certain qualities even of basic steels. Actually, only such steels as exhibit magnetic ageing will show strain etching figures. A very beautiful study of the microscopic changes by Köster shows that the deposition of nitride particles along the slip lines is responsible for the effect. There is, however, no direct relation between the magnetic ageing and strain etching, on the one hand, and the development of brittleness in the course of time on the other, although both are dependent on the separation of nitride from solid solution.

Naturally any element which behaves like nitrogen, dissolving in α-iron at high temperatures and separating out at lower temperatures, will produce similar effects, and this aspect of the subject has been examined in detail by Prof. W. Eilender and Dr. R. Wasmuht, of Aachen, who find that the influence of oxygen is small, but

that both carbon and nitrogen exert a hardening effect when separating out in ultra-microscopic particles from solid solution in α-iron. The fact that the work of Köster was carried out in the research laboratories of a large industrial concern is of interest. It becomes clear, in view of investigations of this kind and of those already published in regard to non-ferrous alloys, that the effect of minute quantities of impurities on the properties of metals may be very great, provided that the solubility relations are such as to allow of the formation of a highly-dispersed precipitate at temperatures falling within the ordinary limits of practical use.

Wire-Drawing and Cold Rolling.

An immense amount of research work is in progress relating to the changes which metals undergo during the process of deformation. This is greatly assisted by the application of the method of X-ray analysis. At the same time, it is desirable that the technical processes of deformation, such as wire-drawing and cold rolling, should be studied quantitatively, so that the amount of work done in producing a given change of form may be accurately known. The Kaiser-Wilhelm Institut für Eisenforschung at Düsseldorf has been actively engaged in this work, and apparatus has been devised for measuring the pressures developed at the rolls or at the dies during the process, whilst records have been kept of the consumption of power when different degrees of reduction are employed. Similar work is in progress at other centres, and experimental rolling mills and wire-drawing benches have been set up in the university laboratories of Sheffield, Breslau and Freiberg.

Hardening of Steel.

Several important contributions to the problem of the changes occurring during the process of quenching carbon steels and the cause of the hardness of quenched steel have appeared during the past year. The problem of taking cooling curves during the very short time occupied by quenching has been solved by several previous investigators, making use of the quick response of the string galvanometer, but the curves have shown spurious breaks due to the cooling liquid, which tends to form a vapour jacket, which subsequently collapses. Prof. Eilender and Dr. Esser, of Aachen, have overcome this difficulty in an ingenious manner by using very small specimens and quenching in a blast of hydrogen. High rates of cooling are thus obtained without disturbance, and the curves indicate the transformations clearly even at the highest rates of quenching.

The evidence points to the conclusion that martensite is a heterogeneous mixture, containing ferrite and cementite in a fine state of division, and not a supersaturated solution of carbide in α-iron. A similar conclusion is reached by Drs. G. Sachs and G. Kurdjumov, of Dahlem, who have used a large single crystal of austenite and have examined its transformations during quenching, both microscopically and by means of X-rays. They confirm the conclusion of some previous writers that a tetragonal phase of iron is present as well as the cubic phase, and they put forward a suggested mechanism of the geometrical re-arrangement occurring during hardening. Altogether, it may be said that the long disputed question of the nature of the process of hardening steel is now approaching solution.

It has only been possible to select a few topics from the mass of research work published during the year. A large part of the work recorded in the proceedings of technical societies naturally refers to the solution of problems of immediate practical interest, but there is an encouraging amount of attention now devoted to fundamental research. The quantity is so far greater in Germany than in this country or in America, but the recognition of the absolute necessity of such work is becoming more and more general, so that the future may be looked forward to with some confidence.

Purchasing Electrical Plant.

By "Kilowatt."

So important is the question of how to purchase electrical plant that one could well write a handbook for the buyer, but for the purpose of these notes it is proposed to give a brief outline of the essential points to be borne in mind when purchasing electric motors for use in foundries.

Although a certain amount of blame lies in other directions, the buyer himself—the owner or works manager of the foundry—is by no means free from blame. He frequently falls to the temptation of buying on price. Let us take for an example the case of a foundry, where it has been decided to install electric power for driving the machinery. It is possible that the owner knows but little of the characteristics of the different types of electrical apparatus, and accordingly invites tenders from electrical contractors for the installation of apparatus sufficient, as he thinks, to meet requirements. He may specify a particular type of motor, or even go so far as to stipulate a particular system of wiring. In general he states his requirements very meagrely, and small wonder then that the tenders submitted may show a wide divergence in the manner of quoting, and in price.

Again, the buyer may call in the services of a contractor already known to him, and after discussion as to the type of suitable apparatus, issue instructions for the work to proceed "at the lowest possible price." Naturally the management of a foundry cannot entirely disregard this question of cost, but they should not allow it to be the sole consideration. There are many systems of wiring, for instance, various types of starting and switchgear, and in many cases it will be found that the more expensive wiring system, or the more costly type of starter, will turn out to be the cheapest in the long run.

When purchasing electric motors the first rule of the buyer should be to specify that the machines conform to the requirements of the British Engineering Standards Association. He may, of course, if he so desires, vary the specification, but, broadly speaking, the general body of requirements can be met by quoting the number of specification together with the desired variation.

The maximum temperature rise, which is the essential of all motor ratings, should conform to the B.E.S.A. specification 168/1926. This is an important feature, and quotations which omit this item should not be accepted.

The next important step to bear in mind when purchasing an electric motor is its speed in relation to its price. Generally speaking, a motor running at, say, 1,500 r.p.m., will be approximately half the price of a motor running at 750 r.p.m., and the 1,500 r.p.m. machine considerably smaller, although the horse power and temperature rise may be the same. In order, therefore, to obtain a low first cost, the higher speed motor is usually offered unless a lower speed is specified. If a high-speed motor is installed on account of lower initial cost, it may be necessary to employ some form of speed-reducing gear, but it should be borne in mind that the efficiency of a high-speed motor is higher than that of the slow-speed motor.

The question of bearings is also of considerable importance. When inviting quotations it is wise to specify the type of bearings required. These bearings should be ball or roller, or a combination of both. The efficiency and reliability of such bearings are unquestionable, and nearly all modern manufacturers producing a machine of good quality are using them.

A further consideration in the purchase of motors is the type of protection required, and the power user must first of all decide what type of machine he requires; whether it be protected type, ventilated enclosed type, pipe ventilated, totally enclosed, and so on, and ensure that the comparison of quotations is equal on this basis.

Briefly, the recognised definitions of the type of electric motors available are as follow:—

(*a*) *Open-End Bracket Machine.*—This machine has end bracket bearings forming an integral part of the machine yoke. It has the advantage of good ventilation, but the restriction that it can only be used in a room free from dust and damp.

(*b*) *Protected Machine.*—One in which the internal rotating and live parts are protected mechanically from accidental or careless contact. A machine of this type is suitable under certain factory conditions.

(*c*) *Enclosed Ventilated Machine.*—One in which the ventilated openings in the frame are protected with an expanded metal screen, the apertures in which, in compliance with the rules, do not exceed ½ sq. in. in area. It is easily ventilated, usually being cooled by an internal fan, and is readily accessible for cleaning and inspection.

(*d*) *Totally-Enclosed Machine.*—Enclosed so as to prevent circulation of air between the inside and outside of the case, but not necessarily air-tight. It is suitable for positions where there is damp or dust of not too fine a nature. As the machine is totally enclosed, and therefore gains no direct ventilation to its windings from the outside air, its heat has to be dissipated by radiation through the case. A slightly increased temperature rise is therefore allowed for this type of machine. The cost of a totally-enclosed machine is approximately 75 per cent. more than that of an enclosed ventilated machine of the same horse-power output.

(*e*) *Pipe-Ventilated Machine.*—This type of motor is so arranged that the ventilating air may be conveyed to or from the machine through pipes attached to the frame. The open ends of the pipes are generally conducted to clean dry air, and in actual cost is very little more than that of the ventilated enclosed pattern.

(*f*) *Drip-Proof Machine.*—This has a frame provided with openings for ventilation, but so protected as to exclude falling water or dirt. Suitable for use in very damp situations.

The type of starting gear should be perfectly clear in the mind of the buyer and in the quotation of the manufacturer. There are many types, each of them suitable for some purposes, but not suitable for all. Often in a quotation for an electric motor a starter of the cheapest possible type is included, and is described in perhaps two or three words. It is not until the motor gets into daily use that one is able to decide on the suitability of the starter.

"Some Notes on Steel Castings."—Mr. J. Jefferson, in the course of a Paper read at the Institution of Engineers and Shipbuilders in Scotland, last month, remarked that, as would be gathered from the Paper, the different processes now used to make steel castings, with the exception of high-frequency induction and other electric furnaces, were much the same as were used 50 years ago, the main advance being in practice. In the old days a few blowholes were rather looked upon with favour as indicating mildness, but now they are frowned upon as indicating bad practice. Some practical hints were given on the design of castings. The author showed that annealing practice had changed somewhat, as quicker cooling had been shown to give better qualities in many cases than the old tedious annealing lasting many days. The main difficulties in making steel castings were due to special properties of the metal, and these difficulties would remain until a metal is formed which, in alloying with steel, would counteract these ill-effects. General engineering did not appear to have taken advantage to the same extent as the motor industry of the different properties which could be given to steel. Owing to recent developments in the use of X-rays, this process could now be applied on a commercial scale for the detection of defects in very special castings. It had been found possible to penetrate 5 in. of steel and detect a defect about ⅛ in. dia.

XUM

A Survey of Light-Castings Manufacture.*

By F. Harris.

Light castings entail a large proportion of liquid metal to produce a comparative small weight of solid castings—for instance, on one particular job in a box 24½ in. by 20 in., fifteen castings are produced with a total weight of 6 lbs., whilst the weight of runners is 4 lbs.; again, what is considered a heavy job is produced in a box slightly larger, viz., 25 in. by 22 in., the total weight of castings being 20 lbs. and the runners 8 lbs. Although there are heavier jobs, they are not on a productive basis, because the number required does not justify the expense of making tackle. If, however, there is any prospect of a job being repeated, it only at periodical intervals, it is advisable to mould these either by the aid of a moulding machine, plate or other means which will simplify the job. It is good policy to carry this out, because a much more satisfactory result is obtained. Moreover, it is cheaper, and one is not entirely dependent on the degree of skill of any individual moulder. Consequently, highly-skilled labour can be advantageously employed in other directions.

Melting Plant Used.

The cupola used by the author is of the Whiting type and has an internal diameter of 24 in. to 25 in., the height of charging hole is

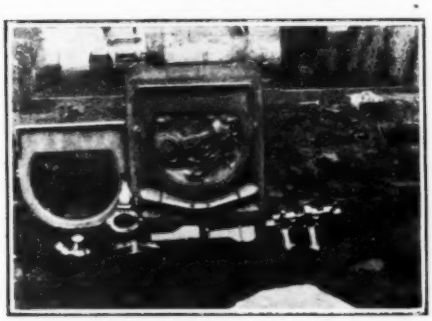


FIG. 1.—A TOP CASTING, A SET OF FEET AND A PAIR OF BRACKETS, SHOWING METHOD OF RUNNING. WEIGHT OF CASTINGS, 20 LBS.; OF RUNNERS, 8 LBS.

10 ft. 6 in., the height of tuyeres is 12 in., whilst the slag hole is 7 in. from the hearth. The tuyere ratio is one-fourth in relation to the area of the furnace at the melting zone; they are of a rectangular shape and flared at their internal ends so as to produce a continuous belt of air entering the furnace. The blast pressure employed is from 6 to 7 ozs. per sq. in. taken from the pressure gauge. The cupola is of the drop-bottom type, which is preferable to the solid-bottom type. Some controversy has taken place as to the merits and demerits of each particular type, and one reason brought forward against the drop-bottom type is that the action of dropping the remaining contents from the furnace after the day's blow is responsible for tearing away parts of the lining. This does not take place, because, as a rule, dropping the contents from the furnace does not occur until the whole of the metal charge has been melted, and by the time this has been completed the bed charge will also be found to have been considerably reduced and will be found to be somewhere about the tuyere level, it being obvious that no destruction to the lining can take place above this level. Moreover, an inspection of the cupola after a few blows will reveal an accumulation of slag and iron on the walls from tuyere level to the hearth, and a periodical removal of this will be necessary.

* A Paper read before the Burnley Section of the Institute of British Foundrymen, Mr. A. Jackson presiding.

Preparing the Cupola.

After the previous day's blow the furnace is dressed and patched up in the usual manner. The patching material is daubed where necessary on the parts that have been burnt out and a new tapping hole made if required. It is important that the patching material should not contain too much moisture, as the generation of steam therefrom may cause the material to peel off during melting operation. The practice of smoothing over with water should not be carried

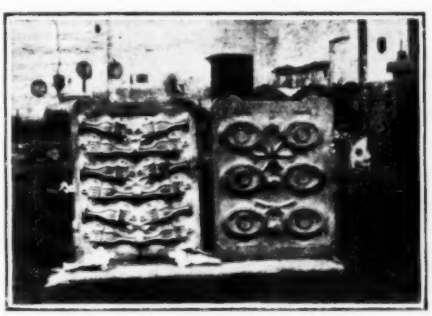


FIG. 2.—THE LEFT-HAND PLATE CARRIES 12 CASTINGS, WEIGHING 15 LBS., AND THE RUNNERS, 4 LBS.; THE RIGHT-HAND PLATE CARRIES 6 LBS. OF CASTINGS AND 4 LBS. OF RUNNERS.

out for the same reason. Personal practice of preparing a tapping hole is to make it with "Silacene," which will probably serve about 40 or 50 blows before being renewed, except, of course, for cleaning away any adhering slag or iron. When making a new tapping hole it is an advantage to form a kind of a drop or step. This little detail is found useful on account of the trouble that is sometimes experienced owing to a deposit of slag and iron immediately in front of the tapping hole, with the result that the metal, instead of quietly running down the

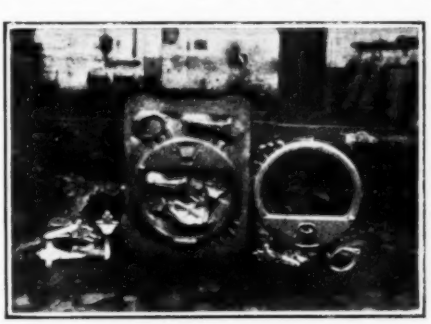


FIG. 3.—A TOP-COVER CASTING $\frac{3}{32}$ IN. THICK WEIGHING 6 LBS. OTHER CASTINGS BRING THE TOTAL TO 11 LBS., WHILST THE RUNNERS WEIGH 9 LBS.

spout, will be found to be issuing from the furnace in the appearance of a fountain—a somewhat dangerous procedure, and great difficulty is experienced in botting-up owing to the metal splashing about the legs and feet of the men in attendance. Of course, much depends on the person performing the tapping operations.

Preparing the Hearth.

The bottom or hearth is then next made up in the usual manner. First the sand used must be correctly damped, as if it were too wet the metal, on reaching the hearth, would begin to boil and would probably be a contributory factor in the production of dull metal at the beginning of the blow, with associated troubles. Secondly, the sand should not be rammed too hard for the same reason. Ordinary black or floor sand has been found to be quite suitable if the above precautions have been taken. Metal leakage through the bottom is very rare unless the ramming operations have been carelessly carried out. The finished hearth must be so constructed that the metal can be entirely drained off through the tapping hole when necessary.

Lighting Up.

The fire is then lighted and allowed to burn until it is burned through to above the tuyeres. The time allowed for lighting should be such that the coke is not unduly wasted before blowing is actually commenced, as this is a precaution against the bed burning hollow. This feature, however, may be detected when gauging the height of bed by the aid of an iron rod or gauge specially kept for that purpose. Whilst the fire is being allowed to burn to a suitable height, the breast-hole may be made up, when the necessary air for combustion enters through the tuyeres, which should be kept open for that purpose. The spout is cleaned and repaired and the slag notch prepared ready for drawing off the slag during the blow. The coke bed entails a weight of 3½ cwts., which brings this to a height of 24 in. above the tuyeres; at the same time this allows for the bed being crushed down somewhat by the subsequent charging operations,

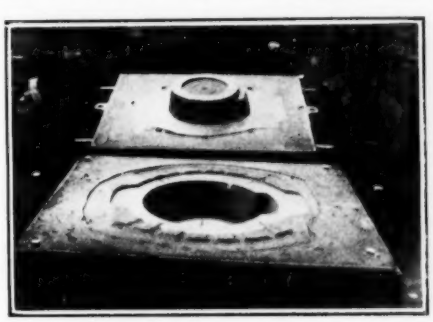


FIG. 4.—PATTERN-PLATE MOULD FOR GREENHOUSE BOILER.

which will consequently arrange itself to about 18 in. above the tuyeres. The height of bed also allows a margin on the safe side, for, as is well known, the height of the fusion zone is somewhat dependent on the blast pressure employed. Actually, the position was determined by trial and error, taking into consideration the amount of coke consumed, the quality of the metal obtained at different stages of the blow (this, by the way, must have a high degree of superheat for light castings), and the general working conditions of the cupola. Various sizes of charges were tried, but the best results were obtained by adopting those of 5 cwts., which is now standard.

Charge Used.

The charge itself consists of ½ cwt. pig, composed of equal parts Staveley No. 3 and Clay Cross No. 3 and 4½ cwts. of scrap, the shop scrap being about 1½ cwts. and outside scrap 3 cwts. Following this is the coke charge, which weighs ½ cwt. A similar charge of iron to the last follows. Then approximately 14 lbs. of limestone is deposited on top of the third charge and this sequence continued throughout the blow, except for the last charge. The charging operations are continued in this fashion until the cupola is full or the required quantity of metal obtained. Metal begins to trickle down the spout from 5 to 10 min. after commencing the blow. The iron from the first tap is generally rather

on the stiff side, which is used on suitable but unimportant castings. A typical charge sheet is shown in Table I.

Table I.—*Cupola Balance Sheet.*

Input.	Cwts.	qrs.	lbs.
Coke	10	2	13
Staveley No. 3 ..	3	0	26
Clay Cross No. 3 ..	3	0	0
Bought scrap ..	41	2	23
Foundry scrap ..	18	3	12
Ganister	1	2	26
Firewood	0	1	4

Output.	Cwts.	qrs.	lbs.
Good castings ..	41	2	10
Returned scrap ..	22	1	13
Scrap castings ..	0	3	10
Metallic loss ..	2	0	0

Overcoming Troubles.

The class of work in hand comprises castings which are comparatively simple to mould, but which must be perfect in appearance. They must possess a smooth skin without any inclusions of slag or dirt, whilst any ornamental work must be true to pattern and clearly distinct, and at the same time they must be soft and easily machinable. This last feature does not present much difficulty, as very seldom are any complaints received, but at one period a great deal of trouble was experienced in getting clean

Fig. 5.—The Bottom Part of a Mould for a Greenhouse Boiler, together with the Core ready for placing in position.

castings, although this has been reduced very considerably, and castings returned for this trouble are practically non-existent.

The castings at one time were returned through slag and dirt, combined with fusing of the sand immediately in front of the runners, making it impossible for the galvanising metal to adhere properly to the castings. The trouble was found to be due to faulty method of gating, which consisted of one, and sometimes two, flat sprays in the drag part of the mould. Two of these were employed as they were cast by the aid of two hand ladles. There was no provision made in the top part for preventing dirt entering the mould. This entailed a great amount of trouble before the evil was finally stopped. First the cupola was checked over to see if anything wrong could be found there. The facing-sand mixing operations were scrutinised; the moulding operations on the part of the moulders was very carefully controlled, all metal was skimmed entirely free of dirt before using, and any unsuitable metal discarded. In fact, every detail that was thought to be any contributory factor to the trouble was modified, but the trouble continued to a more or less degree.

Eventually the management decided to make some improvement to the design of the castings, which fortunately, or unfortunately, necessitated making new pattern plates. Obviously, this was an important change, but one that was definitely worth while, as no further trouble was experienced, and more castings were obtained per box owing to a rearrangement of the patterns when making these plates. The trouble was overcome by placing small flat ingates in the drag part of the mould and connecting these together by a main runner in the top part, with a dirt trap at each end. In special jobs, where the castings must be entirely free from dirt, risers are placed at each end of the main runner. The dirt traps on the top are one of its main features, which have been proved to be effective, as several trials were carried out before it was finally adopted. During these trials, small traps were employed, from which an improvement was observed, but the result was not quite what was desired. After increasing their size no further trouble was experienced. One other point which helps very considerably is to limit the size of the ingates down to a point when they will effectively pour the casting with safety, although a certain amount of judgment and care is necessary. Other reasons for reducing the size of the ingates is effectively to distribute the metal evenly over a large area of the casting in order to avoid one runner passing more metal than another and thus preventing fusing of the sand. This would probably occur opposite the runner passing the bulk of the metal from the main runner. Moreover, the gates break off cleanly and dressing is reduced to a minimum, whilst at the same time giving a much better finish to the casting by avoiding unnecessary grinding. This is considered unsightly on castings where appearance is one of the main factors.

Preparation of Facing Sands.

The facing sand used for these castings is of the following proportions:—

Black or floor sand	6 barrows.
New red sand	1 barrow.
Superfine coal dust... ...	3 buckets.

These constituents are spread in layers on the floor, the necessary amount of water added—the addition of water being left to the judgment of the sand mixer, and the whole thoroughly mixed and riddled, after which it is passed through an ordinary sand mill of the stationary-pan type. It is not milled for any definite length of time, but delivered from the mill continuously, as the delivery shute is kept open during the operation; a slight alteration to the shute increases the speed of delivery. This method of mixing sand is carried out with the object of avoiding the sand produced being unsuitable through over-milling and the difference in shovelling the sand into the mill, and the rather slower delivery allows the sand to be mixed sufficiently without any undue crushing of the sand grains. Moreover, the output of the machine was increased very considerably when working on ordinary facing-sand mixtures, although for core sand and other special sand for tooth wheels and similar castings the shute is kept closed until a suitable strength is obtained.

Some difficulty was experienced at one time in getting the various ingredients of the facing sand in the proper proportions, due to the human element. It was found that a barrowful of sand from one man was found to be nearly double or one and a-half times that of another. A solution to this was found in using a strickle to measure or scrape off the sand above the top edges of the sides of the barrow.

Making Pattern Plates.

Every practical moulder is fully aware of the necessity of high-grade tackle in the way of moulding boxes, patterns, pattern plates and a host of other incidentals which contribute to the moulder's outfit. The pattern plate is one of the most important tools in this branch of foundry work. Various methods are employed in their manufacture, each of which possesses its own advantages. The method adopted is generally dependent on circumstances existing in the particular foundry concerned, such as the number of castings required, the quality and the method of moulding, whether machine or plate moulded by hand on the floor. A moulding box of suitable dimensions is first obtained. This must be in good condition, possessing adequate fitting edges (machined edges are a decided advantage, especially if the box is likely to be in regular use for this purpose). Well-fitting pins are essential as a safeguard against the castings being "twisted," which is a term commonly used by the moulder concerning inaccurate registering of the joint. The top part is first rammed up on the floor, the surplus sand strickled off with a straight-edge; a frame, the same size as the moulding boxes to be used on the job, is placed centrally thereon. This frame should be about $\frac{1}{8}$ in. smaller inside than the inside dimensions of the production moulding box. This is a precaution against the pattern-plate pin-holes not being placed accurately, because, if this does happen and there are any sloping joints, the top or the bottom part of the moulding box would ride thereon, and a great deal of trouble would be entailed in rectifying such an error. The patterns are next set out in their respective positions, with full consideration to runners and the

Fig. 6.—The Mould shown in Fig. 5, illustrating Method of Venting the Main Body Core.

position in which the patterns will work best with a view to getting optimum results. Specially-prepared facing sand is then sieved over the patterns. This should be freely used to ensure that they are properly covered. Sprigs should be inserted in places underneath the patterns to support weak parts. Floor sand is next riddled over this; the box edges are cleaned and the drag part is then located. More sand is then shovelled in and rammed very carefully, the surplus sand being scraped off and the whole thoroughly vented. A good bed is then made, and the complete box turned over on to this and very carefully bedded down. Sand should be rammed under the edges to ensure that there are no hollow places. The top part is lifted off and the joint again vented, this being necessary on account of the close nature of the sand employed. The joint is then made, this being one of the most important factors in the making of a pattern plate, as it must be constructed so as to ensure a good, clean lift and to eliminate trouble when the plate is in use. Sprigs should be freely used to prevent cores and other frail parts being washed away by the flow of the metal and to strengthen parts of the mould that are likely

to swell due to the heat of the metal. Swelling is due to various factors, such as the thickness of metal, its temperature when cast, and the nature of the facing sand. The clay content of facing sand can be a most troublesome element if in excess, yet at the same time it is a necessary constituent.

Closing the Mould.

Before finishing off the joint it may be necessary to camber the joint to counteract any probable warping of the plate. However, this is not advisable unless essential, because, if the plate is cambered, the pattern, if only one pattern is being mounted, must also have been previously cambered, as failure to produce straight castings would result. This is because any warping of the plate would involve the pattern also. It is much better to try and counteract the effect of warping by turning the whole box on its edge and bearing any part such as heavy boss or at any part it is deemed necessary. Parting sand or parting powder is then sprinkled over and facing sand sieved on. The top part of the moulding box is placed in position, sand is shovelled in and rammed up similarly to the drag. The runners are placed in position and the main vents underneath the box are made, when the top part

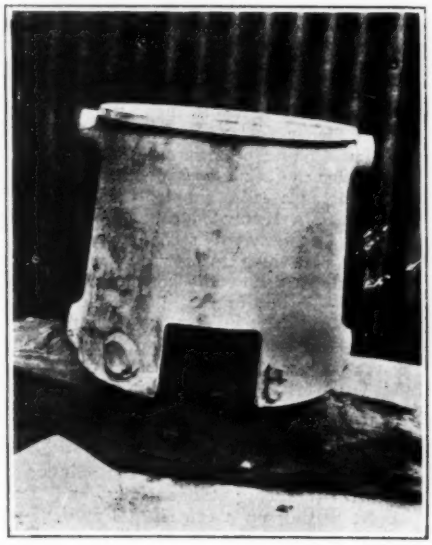


FIG. 7.—THE FINISHED GREENHOUSE-BOILER CASTING.

may be carefully lifted off. The surplus parting sand is brushed carefully off by the aid of a camel-hair brush; the frame is then replaced on the joint in exactly the same position from which it was removed, sprigs or other means of registering having been previously arranged to facilitate its replacement. The joint all round the outside of the frame is next roughened up, and this made up to the level of the top of the frame. This frame is actually the thickness of the plate. Particular care should be exercised in making this perfectly level and to the proper height, because if it is made too high the sand in the vicinity of the joint would be pushed through the bars of the cope during replacement. If it is made too low metal will probably find its way there, with a possibility of a run out and a scrap casting. When the joint has been properly finished off the frame may be withdrawn. The next operation is that of constructing the runners and ingates on the plate itself, after which the patterns may be carefully stripped from the mould, and any damaged parts are then repaired very carefully. A high-grade plumbago should be dusted over and the whole smoothed or sleeked by hand or a camel-hair brush. If the patterns are of simple relief, they may be replaced in exactly the same position and withdrawn immediately, when a good clean impression of the mould should result. The cope is next examined and any repairs that are required are carried out; the runners are made and carefully finished off, when the whole can be dusted and sleeked with plumbago similarly to the drag part. It is advisable at this stage to cut up round the joint and try on the top part to make sure that the top and bottom joints touch evenly and that everything is in perfect order before skin drying the mould is commenced. When this has been effectively carried out the mould is closed, cottered or clamped together and cast. After allowing time for the metal to have solidified, the box is then turned on its side and any thick and heavy parts bared to keep the plate from warping. Competent judgment is necessary in this direction, or one may find from an inspection of the plate that it has warped in an entirely opposite direction to what was expected.

Facing Sands.

The facing sand for pattern-plate moulding is taken from the ordinary sand bin and a little extra coal dust is added, together with a small amount of water, and allowed about two or three minutes in the sand mill. After this it is riddled, when it is ready for use. Probably a better skin could be obtained by using one part each of new red sand and yellow sand and four parts of floor sand, with a suitable amount of coal dust, and milled in the ordinary manner, but very great care is necessary in venting and drying the mould, or scabbing will result, and for this reason it is not recommended unless the moulder is thoroughly aware of its close nature.

Aluminium Melting Practice.

A metal that has become very popular during recent years is aluminium, owing to its lightness, strength, ductility, ease of machining, and other important features, but it is a metal that can be very troublesome to the founder, unless very great care is exercised in melting. When melting aluminium, a temperature equal to a dull red (700 deg. C.) is all that is required, any excess only spoiling the metal. It is a peculiarity of this metal that it "hangs" for a long time before it melts, due to its high latent heat of fusion. When pushing back the skin of oxide which forms over the molten metal, a rich wine colour should be observed, and this will indicate that the metal is in the best condition and at the best temperature for pouring into moulds. A handful of chloride of lime is useful to throw on the molten aluminium as a flux before pouring. This should be gently stirred into the molten metal with a dry wooden stick or skimmer, and the dirt or dross which is thus brought to the surface should be skimmed off before pouring. It may be necessary to skim two or even three times to secure clean metal, particularly so if the aluminium is made from remelted scrap, such as automobile scrap. Place the largest pieces of the metal in the bottom of the crucible, and under no circumstances use fine scrap first, or excessive oxidation will occur, and if the castings to be made are to be of high quality, fine scrap should be entirely eliminated. The metal must not be permitted to become too hot, and further additions of suitable scrap or ingots must be introduced to prevent this until the crucible is full. When sufficient metal has been obtained, allow the temperature to reach that required, then immediately withdraw the crucible from the furnace. From personal experience, if the procedure described has been properly observed, a satisfactory result will be obtained, providing that the moulding operations suitable for aluminium castings have been carried out.

Moulding Aluminium Castings.

The moulding operations are conducted similarly to those for iron, although it is not necessary to employ facings, such as facing sand, plumbago or terra-flake, to the same extent. The moulding sand must be of a suitable composition, possessing a good bond, so that the minimum of water is required in order that the sand will retain its shape of the mould given to it by the moulder. It must also possess a certain degree of porosity, so that steam and gases which are generated by the molten metal can pass through the sand with the minimum of resistance. This is an important factor, as it is not possible to force out of the mould these gases to the same extent as with iron. A mixture of sand found very suitable for this purpose is 50 per cent. each of red and yellow. Similar methods of gating to those used in the iron foundry can be employed in the majority of cases, except, of course, to make them of larger

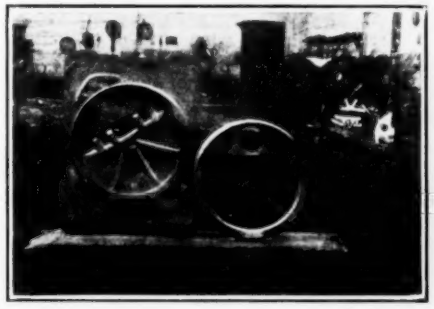


FIG. 8.—A TOP-COVER CASTING MADE IN ALUMINIUM, SHOWING TWO METHODS OF RUNNING—THE CENTRAL METHOD BEING PREFERABLE.

dimensions. It is not possible to obtain the same momentum with molten aluminium as can be obtained with iron.

Cupola Malleable Cast Iron.

(*Continued from page* 104.)

also the size of the cementite areas, the higher the carbon the larger these areas, other conditions being standard. There are other factors which are of equal importance affecting specially the size of cementite. These are: Temperature of pouring, rate of cooling and structural thickness of the castings; as these increase so will the size of the cementite, and this is a very important point to bear in mind if one is to secure a product having good mechanical properties, because the size of the cementite determines the size of the temper-carbon nodules, and it will be easily appreciated how this affects the strength and ductility of the metal.

In regard to temperature of pouring, it is usually recognised that malleable should be melted as hot as possible. Whilst this may be true, it does not follow that the iron should be poured as hot as possible. There are several objections to this:—(1) The higher the pouring temperature the greater the shrinkage, and in some types of castings the greater the tendency to cracking, and (2) the higher the pouring temperature the larger the cementite areas.

Further, Kikuta found that the graphitisation of the free cementite becomes more difficult as the size of the cementite increases. The author has also proved this to his own satisfaction, where cupola malleable is concerned. The most satisfactory pouring temperature is that which will produce a completely-run mould, free from unsoundness. In the pouring of cupola malleable iron, temperatures that give very sharp contours to the casting should not be considered of such importance as is necessary in the case of many types of grey-iron castings. Soundness, strength and ductility are of much greater importance, and it cannot be too strongly emphasised that the temperature of pouring greatly affects these properties.

(To be concluded.)

XUM

The Manufacture and Properties of Malleable Castings.*

By J. K. Smithson.

As this important branch of the ironfounding industry is not represented in the Cleveland area, it may not be out of place if a brief definition is given of the term "malleable castings." By nature of their properties this class of castings may be described as an intermediate product between ordinary grey cast iron and mild steel or wrought iron. They are given the required shape by melting the metal and pouring into moulds in the same way as other castings, and by a subsequent process, known as annealing, the brittleness associated with cast iron is removed and in their final form the castings are tough and ductile enough to withstand considerable deformation without fracture, thus exhibiting properties akin to wrought iron or mild steel, from which the description "malleable" is derived.

There are two distinct types of malleable castings, fundamentally different as to chemical composition, microstructure and method of manufacture, yet having similar mechanical properties. The first process originated in the experiments of Réaumur in 1722, and the metal produced by this method is now known as whiteheart malleable. About 100 years later Seth Boyden, an Englishman who had emigrated to America, found that he was unable to make good malleable castings from the irons available in that country by the whiteheart process with which he was familiar, and his attempts to overcome his difficulties resulted in the production of a new material now known as blackheart malleable. The following remarks refer to whiteheart practice.

Irons Used.

On account of the necessity for the castings being white in the first place, the irons which the malleable founder uses are selected from a range of hematite quality pig-irons low in silicon, varying from grey through increasing degrees of mottled to white. Such irons are of two kinds, one direct-cast from the blast furnace, the other specially refined. The direct-cast material is entirely produced on the West Coast owing to the suitability of the native Cumberland ores on account of their low manganese and phosphorus. The manufacture of the refined type is spread over several of the iron-producing districts, and three or four firms in the Cleveland area are makers of this class of iron.

These irons are graded according to fracture, usually in six grades, and names descriptive of the fracture are given to each grade. Table I gives the designation and shows the typical analysis of the refined irons:—

Table I.—*Refined Irons for Malleable-Casting Work.*

Fracture.	C.C.	Gr.C.	Si.	Mn.	S.	P.
White ..	3.05	0.05	0.50	0.20	0.15	0.06
Spotted white	2.85	0.30	0.64	0.25	0.13	0.06
Hard mottled	2.40	0.75	0.74	0.27	0.12	0.06
Medium mottled	1.60	1.60	0.84	0.28	0.11	0.06
Soft mottled	1.15	2.05	0.90	0.30	0.10	0.06
Grey ..	0.80	2.45	1.00	0.35	0.08	0.06

Mixtures and Cupola Practice.

There is much diversity amongst different founders in the matter of cupola mixtures and the white-iron castings produced from different sources have been found to vary over a wide range, viz.: T.C., 2.9 to 3.3; Si, 0.4 to 0.8; Mn, 0.1 to 0.3; S, 0.15 to 0.35, and P, 0.05 to 0.10 per cent. It is possible to anneal successfully any iron falling within this range given suitable annealing treatment, but different compositions require different annealing treatment. Malleable founders do not as a rule consider it practicable to vary their annealing practice to meet with changes in the composition of the white iron, and prefer to adhere to a standard annealing practice. The aim in cupola working is, therefore, to produce white iron of consistent chemical composition, which is suited to the annealing practice. This is the only consideration which can be allowed to have any weight in determining cupola mixtures. The high shrinkage of white iron, which is about double that of grey iron, necessitates the use of heavy runners and large feeding heads in order to ensure sound, solid castings, and the amount of scrap from this source is on the average about equal to the weight of the castings. Cupola charges have to carry as a rule about 50 per cent. of this scrap material, and its use complicates the question of producing iron of consistent analysis from day to day. There are a great many non-technical malleable founders who have the impression that if a mixture of, say, 50 per cent. of one fracture of pig-iron and 50 per cent. of scrap is always charged into a cupola, it should always yield white iron of the same composition provided the pig-iron does not alter. Experience teaches that this is not the case, as the adoption of such a procedure invariably leads to trouble, the castings remaining hard after annealing. The pig-iron is generally held to blame, and "to protect himself" the founder buys his pig-iron from two or more different sources. This generally renders the incidence of the trouble less frequent, but seldom eliminates it altogether. When the chemical changes which occur in the repeated melting of a large and regular proportion of circulating scrap with new irons of constant composition are studied, it is at once apparent that there is a progressive reduction of silicon and a slight increment of sulphur with each remelt, and the metal sooner or later reaches a point where the silicon content is insufficient for its important function in the annealing process. The light nature of the scrap met with in malleable foundries, with its large ratio of oxidised skin to the bulk of metal, may explain the fact that the silicon losses in melting malleable mixtures are high, and, moreover, tend to be constant for a given set of melting conditions, whatever the silicon content of the mixture may be, rather than to diminish as the silicon content of the mixture decreases, as is the case with ordinary pig-iron mixtures. The greater the proportion of scrap the more rapid is the deterioration of the metal. In order to keep the composition of the white castings within the narrow limits which are essential to successful annealing, it is essential to have two grades of pig-iron and introduce a proportion of the softer grade at frequent intervals to compensate for the unavoidable silicon loss.

In its other aspects the operation of the cupola is not very different from grey practice, except in the matter of coke consumption, which is necessarily much greater in order to obtain the superheat required by this type of metal. The highest quality of foundry coke, low in sulphur, is essential. A high pick-up of sulphur rapidly deteriorates the scrap.

Moulding.

Compared with grey iron, the white iron poured into malleable castings has a much higher liquid and solid contraction, and its short freezing range necessitates high casting temperatures. These conditions impose a great responsibility on the moulder. The infinite variety of work, ranging in weight from a fraction of an ounce to a cwt. or more, makes it impossible to do more than indicate very broadly the distinctive features of malleable moulding practice.

For the lightest classes of work a spray of patterns is made, the individual patterns being fixed to a heavy runner at right-angles, a feeder being interposed between the runner and each pattern in most cases. The moulding of these sprays can be facilitated by the use of a plaster oddside. One-half of a flask is finished in the ordinary way, then a wooden frame, with nails projecting inwards to hold the plaster, is laid on top; the frame is then filled with a mixture of plaster of paris and left to set. A cast of half the spray is thus formed, and this is varnished to give a smooth finish. When used for moulding, the oddside, with spray in position, is laid on the bench, and the bottom half of the flask is placed over it and rammed up. Flask and oddside are then turned over and the oddside lifted off. The mould is then dusted with parting sand and the other half of the box is placed on top, and the mould completed as usual. Castings of medium size are moulded from two to four per box, and a spray of patterns is made round a heavy central feeder.

Those castings which are large enough to be moulded singly generally present the most difficult problems of gating and feeding, and call for a degree of skill and judgment rarely exceeded in the founding of any other metal. In moulding the larger castings, use is made of separate feeder patterns, which should be available in a number of different sizes, from which the moulder can select as his experience dictates. These are, as a rule, simple, tapered blocks in the form of a truncated cone. A most important point to observe in connection with these feeders is that the gate between feeder and casting should not be at the bottom of the feeder. The first splashes of metal are liable to chill and cause the bottom of the feeder, and consequently the gate, to set quicker than the casting and render the feeder non-effective, a danger which is obviated when there is a body of metal below the gate.

Running and Venting.

Many of the feeders are of the spinner type, the metal entering tangentially and leaving radially, setting up a centrifugal motion, which prevents the entrance of dirt into the casting. Sieve runners are also used to exclude dirt. Ample venting and careful control of coal dust are very important points. Excess of coal dust is to be particularly guarded against in light work; the gas pressure set up may be sufficient to prevent the mould filling, and lead to a short run casting. Cores should be as loosely constructed as is consistent with strength to withstand handling, in order to offer the least possible resistance to the free contraction of the castings.

Defects.

Shrinkage cavities are the commonest defects of the white castings. They take the form of spongy porous areas, with a dendritic structure, and are easily distinguishable from blow-holes due to entrapped gases which have been unable to escape from metal poured too cold. The only remedy which can be applied to shrinkage defects is modification of feeding and gating.

Compared with the grey-iron founder, who can alter his mixtures according to the needs of the job in hand, the malleable founder, who is restricted to one class of metal, labours under a serious handicap. From the point of view of producing a sound casting, white iron is never the ideal medium, and designs which present no difficulty in grey iron are often almost impracticable in white iron. On this account, co-operation between purchaser and founder on details of design is more than ever desirable.

* A Paper read before the Middlesbrough Section of the Institute of British Foundrymen, Mr. A. G. Harrison presiding.

The experience of the founder may often suggest some slight modification of detail which will eliminate a foundry difficulty and result in a saving in cost and prove of mutual benefit. When a grey-iron detail is to be repeated in malleable, the greater strength will often allow ribs and stiffeners, necessary in the grey iron, to be dispensed with.

The internal stresses set up in the cooling of the white-iron castings are very severe, and, in order to avoid the development of cracks from this cause, slow cooling must be provided for. With many castings of complicated design and unequal section, the ordinary rate of cooling in the mould is much too rapid, and they should be shaken out of the moulds as soon as they are set, and immediately placed in a muffle furnace, where they should remain at a temperature of 800 to 900 deg. C. for a sufficient duration to relieve tension, and then be slowly cooled, preferably in the furnace itself, but in any case in a position shielded from drafts. A certain amount of cleaning and fettling has to be done prior to annealing. All cores are removed, and the surfaces freed from adherent sand by means of wire brushes. Where the castings are not likely to fracture, they are expeditiously cleaned in tumbling barrels, or may be sandblasted.

Annealing.

The next step in the process is the annealing of the castings. The ovens used for this purpose are simple rectangular fire-brick chambers with arched roofs, and may be fired by means of coal, producer gas or pulverised fuel. The construction must be calculated to withstand the alternate expansion and contraction due to heating up to and cooling down from 1,000 deg. C. The annealing material in which the castings are packed is red hematite iron ore. It should be of a fair degree of purity, containing from 75 to 90 per cent. of ferric oxide. It is crushed and graded by screening into suitable uniform sizes. In the annealing the ferric oxide is reduced to magnetic oxide, and as the action of the unused ore is too severe, new and used ore are mixed for actual use, the new ore comprising from one-tenth to one-third of the mixture according to the needs of the work.

The initial firing must be slow and the rise of temperature even and gradual. Forcing the fire in the early stages often leads to the fracture of castings of complicated section. Twenty-four to forty-eight hours should elapse before the oven reaches the full annealing temperature of 900 to 1,000 deg. C., and from 800 deg. C. upwards extreme caution is necessary to avoid local overrunning of the annealing temperature in the hotter parts of the oven.

After the full annealing temperature is attained the firing of the oven must be carefully controlled to keep fluctuations of temperature within the narrowest possible limits, irregularities being the cause of much spoiled work, especially when the temperature is allowed to get too high even for a short period. The length of time at annealing temperature will vary from 100 to 240 hours, according to the thickness of the castings, the heavier sections requiring the longer time.

A twofold change takes place during the annealing operation. Microscopic examination of well-annealed metal will reveal the fact that the cementite—pearlite structure of the original white iron has disappeared entirely and been replaced by a pearlite-ferrite structure with graphite distributed throughout in a finely-divided nodular condition. It will also be observed that the amount of combined carbon increases progressively towards the centre of the section, the outer edge being practically decarburised. The formation of the graphite is peculiar to malleable castings and entirely different from anything met with in grey iron. Owing to its finely divided amorphous condition, it is thought to act as a lubricant or cushion between the crystal grains of the metal and to be in a large measure responsible for its ductility. Its distinctive properties have led to the adoption of the term "temper carbon" to distinguish it from the ordinary form of graphite. The fracture, too, has now undergone a complete change, and presents a finely crystalline steely appearance.

The elimination of carbon is brought about by the oxidising action of the iron oxide, according to the chemical equation:—

$$3Fe_2O_3+Fe_3C=CO+2Fe_2O_4+3Fe.$$

The carbon is removed from the outer skin of the castings, where the concentration of carbon is reduced as compared with the interior of the castings. This deficiency is compensated for by diffusion of carbon from the next layer and so on. The metal may be considered as a solid solution of carbon in iron. When from any cause the concentration of the dissolved substance is unequal at different parts of a solution, diffusion takes place from the more concentrated part until, in favourable circumstances, the solution becomes homogeneous. In the case of the annealing process, however, the removal of the dissolved substance, carbon, proceeds continuously from one point, the outer edge of the casting, consequently homogeneity is never attained, the carbon content gradually increasing from the outside to the centre. This renders the annealing of thick sections by the whiteheart process a lengthy and difficult process. By prolonged or repeated annealing the annealing will penetrate to a depth of about one inch, but not much more. Hence in the centre of castings over 3 in. thick there is always a core of metal which would only show poor physical properties if a test-bar were cut from it.

The thick outer envelope of true malleable renders the castings very tough and strong, and it is possible to drill right through the centre when required, so that such castings can be made to serve many useful purposes. At the annealing temperature the white iron is structurally saturated austenite plus excess free cementite. As the carbon content falls the saturation of the austenite is maintained by solution of the free cementite until the latter has all been taken up. After this point diffusion continues in the unsaturated austenite, but it seems reasonable to suppose that the process will slow down as the carbon content falls, and the difference of concentration becomes less marked.

The rate at which decarburisation proceeds increases with the temperature, and the rate at which the carbon can diffuse will also be increased with higher temperature. Decarburisation is also influenced by the strength of the oxidising medium, a factor which will not affect the rate of diffusion except indirectly, as a greater or less rate of diffusion is called for according to the rate of decarburisation. Assuming the foregoing to be correct, these factors would appear to have a considerable bearing on a common defect of whiteheart castings. A decarburised outer layer, about $\frac{1}{16}$ in. in thickness, detaches itself from the body of the casting when it is bent or hammered. This phenomenon is known as peeling. This skin or peel is always markedly lower in carbon than the rest of the metal. The following analyses of the two portions of such a casting illustrates this very well:—

	Gr.C.	C.C.	Si.	Mn.	S.	P.
Peeled skin	0.05	0.09	0.64	0.27	0.21	0.062
Body of casting ..	0.49	0.52	0.64	0.27	0.23	0.062

Many theories have been advanced in explanation of peeling, but none seem entirely adequate. To the author's mind, it seems most probable that ore strength is the factor most likely to be responsible. From what has already been said of the manner in which decarburisation takes place, it will be clear that carbon must only be eliminated at such a rate that diffusion can keep up with it. In the case of a peeled casting this had obviously not been the case, the rate of decarburisation having exceeded the rate of diffusion.

In their effect on graphitisation the several elements behave as might be expected from a knowledge of their influence in the cooling of grey cast iron. Metal with high total carbon will graphitise more readily than lower total-carbon metal. The higher the silicon the more readily will graphite be formed. Sulphur retains carbon on the combined condition, and retards graphite formation. Manganese, by combining with the sulphur to form manganese sulphide, in which form the sulphur does not affect the precipitation of graphite, may be said to act indirectly as a graphitiser, at any rate, up to a point some 0.3 per cent. in excess of the amount required to satisfy the sulphur. Beyond this point manganese exerts exactly the opposite influence. The four elements are, therefore, mutually interdependent as regards their effects on graphitisation, and nothing less than a complete analysis of white iron will give a reliable guide to its annealing properties.

Phosphorus has not been mentioned, as it does not affect graphitisation and may be considered separately. Its effect in malleable iron is similar to its effect in steel, *i.e.*, it induces "cold-shortness," and lowers resistance to shock, and it must, therefore, be kept as low as possible; 2 per cent. is generally recognised as the maximum permissible.

From what has been said of the manner in which decarburisation takes place, it will be clear that the process must inevitably be a slow and gradual one. The graphitising process must necessarily also be equally slow in order that a proper balance may be kept between the combined and free carbon. Metal which deposits free carbon rapidly is a frequent cause of poor malleable. The castings after annealing are extremely soft and readily machinable, but have no ductility, giving only a small degree of bend. The tensile test is also low, and the metal is aptly described as "rotten." Micro-examination shows the temper carbon to be excessive in amount and in a very coarse state.

The following analysis is typical of such metal:—Gr.C., 1.81; C.C., 0.24; Si, 0.76; Mn, 0.27; S, 0.175; and P, 0.069 per cent. There are, of course, three ways of regarding this, one may say that the iron was too high in silicon, that the unbalanced sulphur was too little or that the annealing temperature has been too high. There is plenty of good malleable made in this range, though perhaps not the best. It is quite readily annealed to give good results at temperatures below normal, provided a longer annealing period is allowed to compensate for the slower rate of decarburisation at the lower temperature.

The following is the analysis of a good casting of similar composition annealed under more favourable conditions:—Gr, 0.71; C.C., 0.35; Si, 0.72; Mn, 0.28; S, 0.22; and P, 0.058 per cent. In this instance the temper carbon was finely divided and the ductility and other physical properties all that could be desired, proving that this metal is capable of being satisfactorily annealed. Of a large number of castings containing over 0.7 per cent. silicon and under 0.25 per cent. sulphur, about 70 per cent. have been found to suffer from the coarse temper carbon defect; hence it would seem that such a composition is not suited to the general average of annealing practice, and it is better that silicon should be kept under 0.7 per cent., except in cases where the founder is regularly accustomed to annealing higher silicon metal. This type of trouble is not confined to high-silicon metal only, and is liable to occur in almost any range of analysis if the annealing temperature is allowed to run too high; with lower silicon, however, the danger is not so acute.

When the sulphur is high, high silicon is essential. The following is an instance of this type

XUM

of metal, which had good physical properties: – Gr, 0.30; C.C., 0.19; Si, 0.78; Mn, 0.11; S, 0.42; and P, 0.06 per cent.

When high silicon is associated with high carbon in the unannealed metal, there is the added risk of the castings not being perfectly white in fracture. Graphite in the unannealed castings is more injurious than coarse-temper carbon, and this provides an added reason why high silicon should be avoided. The main point which it has been desired to make clear up to the present is, that ductility depends to a large extent on the degree of fineness of the temper carbon.

Sufficient has now been said of the influence of composition to make clear its chief function, namely, control of graphitisation, and indirectly the combined carbon. It is difficult to enumerate any hard-and-fast rule with regard to composition, as the annealing conditions are subject to variation, and a given composition which gave good results in one works might prove a failure in another. Silicon, however, may be considered the main controlling element, and with average sulphur and manganese contents, 0.5 to 0.7 per cent. seems to be the most suitable range for average conditions of annealing.

When all factors are under control, material of differing physical characteristics can be produced to meet with different requirements. At the expense of a certain amount of ductility, increased tensile strength and resilience can be secured, and for some purposes a stiffer type of metal is preferable to metal which is extremely ductile. The most ductile type of malleable has predominently ferritic structure, and as the amount of pearlite increases, the metal becomes less ductile and tensile strength increases. The first analysis is of the following ductile metal, and the second is of a stronger and stiffer metal, the essential difference being in the carbon content:—

Gr.C.	C.C.	Si.	Mn.	S.	P.
0.48	0.27	0.56	0.20	0.22	0.068
0.70	0.59	0.50	0.22	0.25	0.065

Many engineers are prejudiced against malleable castings on account of these variations, but if the type of metal required or the purpose for which it is to be used is specified, most malleable founders will undertake to supply suitable material. When proper advantage is taken of these variations, the range of applications of malleable castings will be widened.

Test-Bar Difficulties.

On account of the light nature of a great part of malleable production, it is difficult to relate them to test-bars which would accurately represent their physical properties. Such castings are generally subjected to some form of twisting, bending or hammering test, and their qualities are judged by the amount of distortion they will undergo without fracture. Such tests set the stiffer metal at discount. Not all metal which only shows a moderate bend is bad, though a good deal is very bad, and it requires a little experience to discriminate between good and bad metal of this type without recourse to definite physical tests.

	½-in. dia. U.T.S.	Elongation.	1 by ½-in Bend deg.
Average of 162 consecutive tests	24.6	8.3	57
Bar with highest tensile ..	31.0	4.0	30
Bar with lowest tensile ..	22.8	8.0	95
Bar with highest elongation	25.6	15.3	60
Bar with lowest elongation	31.00	4.0	30

The latest B.E.S.A. specification for whiteheart malleable No. 309 calls for the following figures:—*Ultimate tensile strength* (minimum), 20 tons per sq. in.; elongation in 2 in., 5 per cent. minimum; and bend cold round 1-in. radius (minimum), 45 deg.

As an indication of what can be obtained from whiteheart, the following figures are quoted from a Paper* by Peace and Evans. The results are of an extensive series of tests, and form a reliable guide to the physical properties of good malleable castings.

The difference between bar of highest tensile and lowest tensile further illustrates the fact already referred to that whiteheart malleable can be varied in physical properties to suit varying requirements.

Blackheart Malleable.

Blackheart castings as cast are white in fracture, but the composition of the white iron differs considerably from the iron used for whiteheart, being low in sulphur, higher in silicon and manganese and lower in total carbon. The range of composition for blackheart generally falls within the following limits:—T.C., 2.2 to 2.8; Si, 0.7 to 1.0; Mn, 0.3 to 0.4; S, 0.03 to 0.8; and P, 0.2 per cent. max. The higher silicon is associated with the lower total carbon and *vice versa*. The necessity for low sulphur and low total carbon rules out the cupola for melting purposes, and the air furnace is normally used for melting blackheart. The metal has very similar casting properties to the whiteheart type, the lower carbon being compensated by the higher silicon. Methods of moulding, gating and feeding are therefore substantially the same for both materials.

Annealing Practice.

The principles involved in the annealing differ from whiteheart. When the analyses of the two types of hard iron are compared, it is evident that the blackheart, by reason of its higher silicon content and its lower sulphur, effectively balance by manganese, is a metal which will graphitise much more readily than the whiteheart metal. Graphitisation only is relied upon for malleablising blackheart, and the packing which surrounds the castings in the annealing pans is crushed slag or other non-oxidising material. No decarburisation takes place, and the function of the packing is merely to support the castings and to exclude air. Annealing furnaces, pans and details of packing may be the same for blackheart and whiteheart. The sensitiveness of the hard iron calls for a much lower annealing temperature than is the case with whiteheart, and the actual annealing temperature is from 850 to 880 deg. C.

As a result of the annealing process the metal is completely graphitised, the amount of carbon remaining in the combined form being very small indeed. The amount of carbon removed by oxidation is negligible. Unlike whiteheart, the structure is uniform throughout, and the malleablising effect penetrates to the centre of the thickest section. The microstructure shows a matrix of ferrite, interspersed with fine temper carbon nodules.

	M.S. Tons sq. in.	Elongation % in 2 in.	Bend deg.
Average of 100 consecutive tests	24.8	19.9	175
Bar with highest tensile ..	27.0	19.0	180
Bar with lowest tensile ..	22.2	19.0	180
Bar with highest elongation	24.88	27.0	180
Bar with lowest elongation	24.36	13.0	160
	⅞ dia.		1 by ½ in.

Blackheart malleable is more ductile than whiteheart, the elongation and bend figures being generally higher, but the tensile is approximately the same. The following figures are stipulated in B.E.S.A. Specification No. 310:—*Ultimate tensile strength* (minimum), 20 tons sq. in.; *elongation* in 2 in. (minimum), 7.5 per cent.; *bend cold* round 1-in. radius (minimum), 90 deg.

From the same source† as the whiteheart test, the following figures will be of interest for comparative purpose.

Malleable castings are used in so many branches of industry and for such a diversity of purposes that it would be impossible to reproduce a comprehensive list within reasonable space. The final application in the construction of practically all types of engines, boilers, motor cars, motor cycles and bicycles, agricultural machinery, pipe fittings, mining gear, railway-work tools, domestic and other ornamental-iron works, blocks, keys and so on right down to the humble boot protector. The range is almost infinite, and, in spite of the competition in recent years of small drop forgings, die stampings and steel castings, malleable appears to be holding its own, and will undoubtedly continue to do so if it responds to the stimulus of competition by progressing along scientific lines. That there is a great deal of room for improvement is indisputable. An industry which has been established for some 200 years and has had no serious competition for the greater part of that time is bound to be more or less conservative, and in the malleable foundry the metallurgist and chemist are regarded with no less suspicion than in many other places, hence the application of scientific research is slow. The high standard of work which is turned out by many foundries without any sort of technical control is amazing, when the complexity of the process is realised, and the scientist must first of all learn that many generations of practical experience are not to be despised lightly. What at first sight seems to be mere ignorant prejudice on the part of a practical man has, in nine cases out of ten, a sound scientific basis when all the facts are thoroughly probed, and when the scientifically-trained man enters the malleable foundry prepared to treat the accumulated experience of the practical man with due respect and to give full consideration to the exigencies of daily routine, he will receive a warmer welcome. In the meantime, however, malleable is a very useful material, and probably stands unique for its reign of general usefulness. Why a malleable foundry has never been established in the Middlesbrough district has always been a puzzle to the author.

* FOUNDRY TRADE JOURNAL, June 28, 1928.
† *Ibid.*

Patent Specifications Accepted.

The following list of Patent Specifications accepted has been taken from the "Illustrated Official Journal (Patents)." Printed copies of the full Specifications are obtainable from the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1s. each. The last numbers given are those under which the Specifications will be printed and abridged, and all subsequent proceedings will be taken.

27,464. PIWOWARSKY, E. Production of high-grade castings from high-carbon alloys. 341,436.

28,013. STIRLING, C., and UNITED STEEL COMPANIES, LIMITED. Laminated spring couplings. 341,459.

30,811. TARTRAIS, E. H. Process of and apparatus for coating cylindrical metal members with a hard metal. 341,406.

32,067. STONE & COMPANY, LIMITED, J., BOWER, A. S., and LUDBROOK, R. Method and apparatus for the pressure-casting of metals. 341,557.

31,107. HARTSTOFF-METALL AKT.-GES. (HAMETAG). Production of sheet-like metal grains. 341,561.

37,185. MCLEOD, R. J. Metal-milling machines. 341,646.

37,348. CRONING, J. Metal-casting processes. 341,649.

38,134. HOPPE, O. Metal-milling machines. 341,663.

38,460. POSSENTI, A., and SCORZA, C. Method and apparatus for coating the inside of one or more hollow bodies with foundry sand or similar material, and particularly for moulding shells for casting bodies having the shape of a solid of revolution. 341,673.

1,052. HARDING, T. C., and BROOK, W. Stranding and closing machines for producing wire strands and wire ropes. 341,705.

A Novel Combination Jolt-Squeeze Moulding Machine.

In modern multiple-production foundries, especially in those attached to motor-car or textile-machinery manufacture, great attention is now being paid to obtaining a really well-designed and strongly-built completely automatically-controlled moulding machine.

In the case of ordinary press moulding machines, *i.e.*, moulding machines with hand, pneumatic or hydraulic pressing devices, it is virtually impossible, with deep moulding boxes or when moulding patterns of more or less complicated design, to avoid a certain amount of hand ramming or hand pressing against the inside walls of the boxes and under traverses before finally mechanically squeezing. Thereby not only much time is constantly lost, but the moulder speedily tires and the ramming inevitably becomes less perfect. This extra hand-ramming work is completely eliminated when using a pneumatic moulding machine which embodies in its design, in addition to the pressing device, a pneumatic jolting device. The sand in the average machine is first jolted in the box for some seconds, after which it is further compressed by the top pressing device. It is preferable, however, if possible, to jolt and press simultaneously, and these two operations are combined in a unique manner by the shockless jolt and press moulding machine, type RPD, illustrated in Fig. 1, which machine is manufactured by the Badische Maschinenfabrik, of Durlach. This machine is arranged as a lift-off machine, so that, after the complete sand compression, the pattern and mould are separated without first turning over the box and mould. After the completed ramming of the mould, the box remains on the lifting pins, and is lifted up automatically, together with the moulding table, as shown in Fig. 2, whereupon, on relieving the pressure, the moulding table with the attached pattern plate automatically descends, whilst the lifting pins upon which the box is resting remain at the top position until the box is lifted away (Fig. 3). After releasing the pawl, the lifting pins descend quite noiselessly, being caught up by an oil dashpot, into their bottom position. The release can be effected either by a hand lever or by foot pedal. When moulding deep patterns with steep walls, such as gear wheels, flanged valves, chairs, and the like, a stripping plate can be used, and thereby the machine can be operated perfectly as a stripping type of moulding machine. In that case the stripping plate carrying the moulding box remains on the four lifting pins, whilst the pattern only descends. The stripping plate is made exactly to the outline profile of the patterns, thus preventing any damaging of the mould. Before the pattern is withdrawn, the vibrator is started up and separates the pattern cleanly and perfectly from the sand.

Fig. 1.—RPD Type of Shockless Jolt and Press Moulding Machine, by the Badische Maschinenfabrik, Durlach.

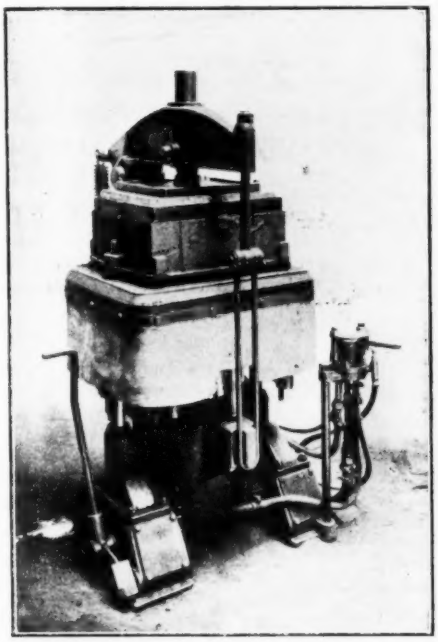


Fig. 2.—The Box and Moulding Table are lifted up after the Mould is completely rammed.

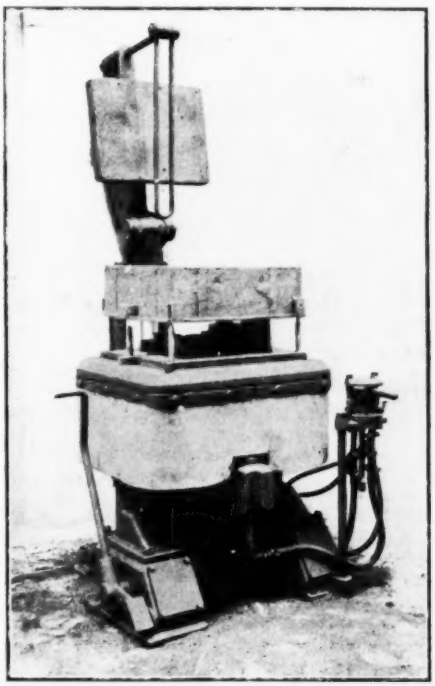


Fig. 3.—The Moulding Table with Pattern Plate descends, and the Box may be lifted away.

Generally, lifting pins are supplied for lifting the moulding box, and the pins rise directly under the corners of the boxes. As some foundries have their pattern plates arranged for working with lifting frames, the RPD machine is fitted in such a manner that it can be worked equally well with either lifting pins or frames. Thus the lifting frame, with the moulding box lying on it, remains at the highest position after the complete sand ramming, whilst the pattern descends, and the box can then be easily and speedily removed.

In order to avoid any special foundations for these machines and to be able to place them near conveyors or in any desired position in quantity-production foundries, they are furnished with a bolster frame to render the vibration shocks negligible. This bolster frame further accelerates the compression of the sand by doubling the effect of the jolting, thus utilising the compressive power of the air to the maximum degree; as a result, with this machine it is possible to jolt and compress one-half flask in about 4 seconds.

The presser-head plate and the lifting pins can be adjusted within considerable range, the pins having three adjustments to allow boxes of different depths to be dealt with so as to avoid unnecessary lifting, and thus saving time, air consumption and as a result maximum production is maintained. Another valuable adaptation of this machine is that it can be used for small repetition work by fixing one-half of the pattern on the press plate, whereby the two halves of the pattern can be moulded in one shallow box and mounted on top of each other for pouring. By this means important box costs are saved. It can also be used in conjunction with collapsible boxes as illustrated for producing boxless moulds. An air hose is provided with each machine for keeping the pattern and pattern plate and machine free from sand, dirt and dust.

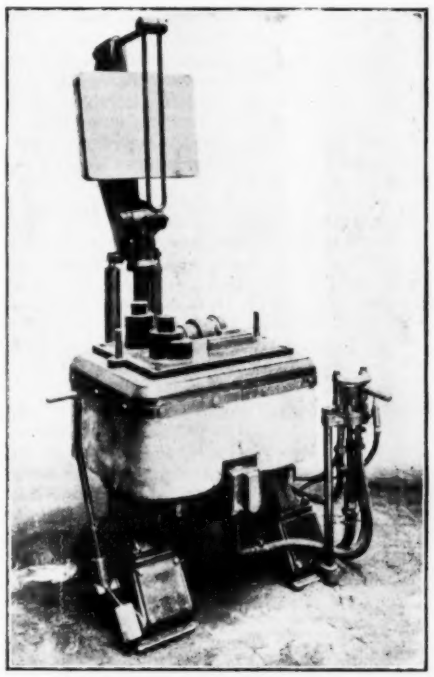


Fig. 4.—Showing the Press-head of the RPD Jolt-Squeeze Moulding Machine.

Since many modern foundries are now using

(*Concluded on page* 114.)

Deoxidation of Steel.

OPEN-HEARTH PRACTICE.

The Department of Commerce of the U.S. Bureau of Mines has issued report of investigation No. 3054 by Dr. C. H. Herty on "Fundamental and Applied Research on the Physical Chemistry of Steel-Making," which states that the first deoxidiser studied by the department in open-hearth practice was silicon. This study dealt with deoxidation of low- and medium-carbon steels with silicon. The results showed that when silicon alone was used as a deoxidiser, silica and silicate particles inevitably resulted in the finished product and that it was extremely difficult to get a fair cleaning of the bath before a reboil commenced. It was found in this work that the larger the particle the more rapid the cleaning of the bath, as would be expected from Stokes' law, and various other factors affecting deoxidation and oxidation of open-hearth steel were discussed.

The work on deoxidation with manganese and silicon and manganese-silicon alloys in the basic open-hearth furnace has been the centre of attention of the plant research men on the staff for the past year. Twenty-five heats have been made during the past year using manganese (as ferro or spiegel) and silicon pig, special silicon-manganese alloys, and high-silicon spiegel for deoxidation. Of these heats the first 15 were completely reboiled and then made into either rimmed or killed steel, and the remainder were tapped while still dead.

Elimination of Non-Metallic Matter.

The elimination of non-metallic matter was hastened by using manganese (either as ferro or spiegel) ahead of the silicon. When using the silicon-manganese alloy and the high-silicon spiegel the elimination was speeded up still further. These results were obtained on heats which were fully reboiled. At this point it was felt that enough data had been accumulated to outline a practice for making low- and medium-carbon killed steels with the use of manganese and silicon as alloys which would produce a cleaner steel than could be obtained by the use of silicon alone. Accordingly, a number of heats were made where the bath was killed with silicon-manganese alloys and high-silicon spiegel, and the heats were tapped while the bath was still dead. Two very interesting conclusions were drawn from the first few heats studied:—

(1) Although the heats were fairly clean at the time the metal was tapped, the addition of silicon in the ladle resulted in the formation of silicate inclusions which were found in the pouring tests and ingots. The analysis of the steel in the furnace showed that inclusions present contained a good deal more manganese oxide than silica, whereas the steel in the ladle after the addition of ferro-silicon in the ladle contained more silica than manganese oxide. This point leads to the conclusion that either deoxidation must be more complete in the furnace or silicon must not be used in the ladle if the cleanest steel is desired. In making low-carbon killed steels with high-silicon spiegel it is impossible to use as much of the alloy as desired on account of the carbon content. It was therefore decided to kill two heats in the furnace with as much high-silicon spiegel as could be put in without going above specifications for carbon and to complete the deoxidation in the mould with aluminium. The heats so treated showed a low aluminium consumption in the moulds, the amount used being about 1.5 ozs. per ton of steel. The finished steel showed a very low chipping cost and extremely low rejections due to surface defects, and was also as clean as has been observed. This procedure is being followed on other heats of steel.

(2) It was found that the addition of a small amount of ferro-manganese in the furnace after the heat had been killed with the silicon-manganese alloys was very effective in cleaning up residual oxides in the metal. Accordingly, the present furnace practice in making low-carbon killed steel is to add the high-silicon spiegel, allow the bath to lie dead for 8 to 12 min., add ferro-manganese to meet specifications, and then tap the heat 10 to 15 min. after the ferro-manganese addition. At present, comparison is being made between steels treated with ferro-silicon in the ladle and with aluminium in the moulds. These developments have opened up a new subject for research—namely, the possibility of using a double deoxidiser in the ladle rather than straight ferro-silicon, as addition of the latter to the ladle inevitably results in silicate inclusions in the ingot.

It is interesting to note that during the past year 25 heats have been studied completely, whereas it required some 2½ years to complete the investigation of 12 heats of steel treated with silicon. This increase in the number of heats studied per year is due primarily to the three improvements in methods of analysis—namely, the determination of FeO in liquid steel by deoxidation with aluminium, and the determination of non-metallic content of steel by the inclusion-count method and by the electrolytic method.

Research of Acid Open-Hearth Steel.

Research has been in progress for the last eight months on oxidation and deoxidation of acid open-hearth steel. The aluminium method for determining FeO in liquid steel has been used throughout this work, as have the inclusion-count and electrolytic methods for determining inclusions in steel.

Some of the striking results of this investigation are: (1) Although the steel may be cleaned considerably by good action in the bath (a rapid rate of carbon elimination) during the early stages of the heat, there is apparently a critical point at which contamination from bottom material commences. By the proper use of spiegel for reboiling, this contaminating matter is very largely eliminated. (2) The use of double deoxidisers of manganese and silicon has improved the cleanliness of the steel considerably compared to the use of ferro-manganese and ferro-silicon. The finished product is more uniform in physical properties after deoxidation with a double or compound alloy.

A Novel Combination Jolt-Squeeze Moulding Machine.

(*Concluded from page* 113.)

automatically-controlled distributing equipments for filling the sand into the flasks, and, further, as they often work on the continuous-casting process by the use of conveyors, it is advisable so as to obtain the maximum output of this machine to install above each machine a hopper which can be so arranged as to drop approximately the exact amount of sand into the box, which sand should be conveyed directly from a suitable sand-preparing plant to the overhead bins.

For this reason the press-head of the RPD moulding machine is so designed that it can be tilted vertically, as shown in Fig. 4, and thereby the space immediately above the moulding table and box remains perfectly clear, which permits any suitable kind of hopper opening device to be used for filling the flask.

The box-output capacity of this RPD machine is extremely high when worked under the most modern conditions, as 700 half-boxes containing one or more patterns can be made in eight hours by one machine alone. The depth and size of the moulding boxes will control the daily output in all cases.

This machine, which is made in three standard sizes—viz., 16 in. by 20 in., 20 in. by 24½ in. and 20 in. by 32 in.—is not only well constructed but is very strongly built of the very best material and workmanship so as to eliminate any continuous and costly maintenance and repairs.

Postmasburg Manganese Ore.

HANDLING ARRANGEMENTS.

The Manganese Corporation of South Africa is about to experiment with an aerial ropeway for handling the ore at the quarry. The equipment is designed to convey empty pans into the quarry and to bring out full ones and deposit them in their wheeled frames on the surface.

Two lattice masts or derricks, some 15 ft. high, with flat bases, are to be set up, one on either side of a quarry, on the natural surface of the ground, without special foundations. On top of each mast is a grooved cast-iron saddle. A stationary rope, 1¼ in. dia., is slung over these saddles, between the masts, across the quarry, and led to anchorages at the back of each mast.

Running on the stationary or suspension rope is a traveller, consisting of a plate frame carrying grooved pulleys, two of which run on the rope. The position of this traveller is controlled by a travelling rope, led from a pin on one side of the frame over a pulley on the one derrick, down to a balance weight, back to another pulley side by side with the first, then back over a pulley on the traveller, across to the second derrick, passing down to one drum of a hoist, round which it takes two or three turns, back over the derrick to the traveller, where it is shackled off to a pin as at the starting point. Rotation of the hoist drum will thus move the traveller along the suspension rope as requisite, the tension being maintained and any stretch compensated by a floating balance weight.

The hoisting rope is anchored at one end, at the same point as the stationary rope. From there it passes over a pulley on the derrick, across to the traveller, over a fixed pulley therein, through a snatch-block, back over a second pulley, to the other derrick, and finally to the second drum of the hoist. Winding in this rope raises the snatch-block and slacking off lowers it. When the traveller is moved by turning the first drum, the hoisting rope merely runs through the two pulleys on the traveller and through the snatch-block.

The system will be operated by means of a 35-h.p. electrically-driven double-drum hoist, each drum being provided with clutch and brake. The span is 350 ft. between derricks, and it is proposed to lay double tracks on the surface, inside each derrick, at right-angles to the ropeway. One track is for full and the other for empty pans. The traveller having been spotted over an empty pan, the body is slung by a chain to the snatch-block, lifted out of its frame and carried out over the quarry, lowered and swung out either way to a convenient loading point. The sling will then be transferred to a full pan and the latter brought back and dropped into a waiting frame on the bank.

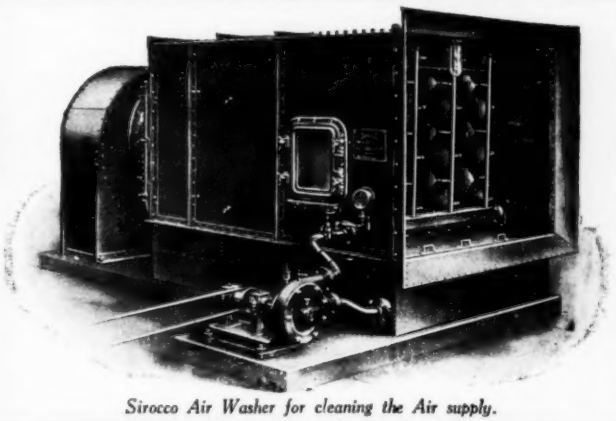
Every part of the gear is so designed that the whole may be described as portable, and very little time would be taken in dismantling, flitting and re-erecting. Thus one equipment should adequately serve a retreating quarry face.

Each 16-cub.-ft. pan will contain about a ton of ore, and the gear is designed for a total suspended load of 2½ tons.—"S.A. Mining and Engineering Journal."

The accounts of the Fried. Krupp A.-G., of Essen, show for the year ending September 30 a loss of £220,000, compared with a profit of £345,500 in the preceding year. The gross revenue of £1,590,000, however, is only about £400,000 smaller than that for the previous year. In the opinion of the directors, the present depression in German trade and industry is not so much due to a world economic crisis as to the burdens imposed upon Germany by the Young plan and the present rates of wages, social services and taxes. During the year, the steelworks were utilised to 60 per cent. of their capacity, the rolling mills to 45 per cent. and the forges to 40 per cent. The number of men employed declined from 68,000 on September 30, 1929, to 57,500 at the end of the financial year.

TRADE SIROCCO MARK

HEATING and VENTILATING EQUIPMENTS



Sirocco Air Washer for cleaning the Air supply.

Central Heating Plants on the hot air principle for large or small buildings, providing an ample supply of pure fresh air at any desired temperature.

Steam Turbine Heater Units in which the steam driving the Fan heats the air supply. A simple and effective method of supplementing an insufficient heating plant. Send for Catalogue No. 8.

DAVIDSON & CO., LIMITED,

Sirocco Engineering Works —— Belfast.

LONDON, GLASGOW, CARDIFF, BRISTOL, MANCHESTER, BIRMINGHAM, NEWCASTLE.

SIEMENS' STEEL PROCESS

BOILER, SHIP and BRIDGE PLATES, etc. ANGLES and all forms of Sectional Bars. TYRES and AXLES to all requirements. CASTINGS of all kinds and of Largest Sizes. FORGINGS of every description. BILLETS, BLOOMS, RAILS.

SPECIAL STEEL FOR CONSTRUCTIVE PURPOSES.

The STEEL COMPANY OF SCOTLAND, Ltd.

Head Office: 37, RENFIELD STREET, GLASGOW:
Works: HALLSIDE, NEWTON and BLOCHAIRN, GLASGOW.

CONTRACTORS TO HOME, COLONIAL AND FOREIGN GOVERNMENTS.

Established 1872. ***Telegraphic Address: "Steel, Glasgow."***

GANISTER, CUPOLA BLOCKS, FIRE BRICKS,

FIRE CLAY.

Silica Bricks, Tuyeres, Stoppers, Nozzles, &c.

STEEL MOULDERS' COMPOSITION, SILICA CEMENT.

J. GRAYSON LOWOOD & CO., LTD.

DEEPCAR, nr. SHEFFIELD.

Telegrams: "LOWOOD, DEEPCAR."

Trade Talk.

The London County Council have accepted the tender of Messrs. Dorman, Long & Company, Limited, amounting to £50,926 for the supply of tramway track rails and fishplates.

The London & North Eastern Railway Company have ordered from the Clyde Crane & Engineering Company, Limited, Mossend, four 3-ton crank-operated cranes for the Royal Dock, Grimsby.

Mining & Industrial Equipment, Limited, 11, Southampton Row, London, W.C.1, report the receipt of an order for a Raymond pulveriser for use in England, and orders from China for two Lopulco mills.

As a result of the audit of the books of the employers in the Scottish manufactured iron trade, the average net selling price has been certified as £10 9s. 8.7d. Wages will therefore remain unchanged.

The "Sentinel" Waggon Works, Limited, Shrewsbury, have recently completed an order for twelve of their six-wheeled three-way tipping wagons for the St. Mary's Wharf Cartage Company, Limited, of London.

The Clyde secured only one order in January. The amount of work on hand at present is 380,000 tons, compared with 550,000 tons a year ago. During the month eight ships of 31,642 tons were launched, and this output compares favourably with last year's.

The Chemical & Metallurgical Corporation, Limited, announce that all matters the subject of litigation between the Corporation and Mr. Stanley Smith, late managing director, have been amicably settled by mutually satisfactory arrangement between the parties.

The directors of the National Electric Construction Company, Limited, announce that they have received from the British Electric Traction Company, Limited, an offer for the purchase of the whole of the company's 170,000 10s. shares at 30s. per share, including any final dividend in respect of 1930.

The London County Council has agreed to contribute £150,000 towards the cost of constructing a tunnel beneath the Thames to link Dartford and Purfleet. The total cost is estimated at £3,000,000, of which £2,250,000 is to be found from the Road Fund, leaving £750,000 to be raised by the local authorities concerned.

Notices have been posted in the Cowlairs works of the London & North Eastern Railway Company at Springburn intimating that all the workers who have attained the age of 68 years will terminate their employment in June. On and after June 30 the services of all employees will be dispensed with when they attain the age of 65.

A power transformer weighing 93 tons was on January 25 successfully moved from a railway truck in a siding at Deptford to the Deptford substation of the Central Electricity Board, where it will be installed. The transformer was made at the works of Messrs. Ferranti, Limited, at Hollinwood, Lancashire, and brought to London by train.

The directors of the German General Electric Company (A.E.G.) propose to pay a dividend of 7 per cent. (as compared with 9 per cent. in the previous year). The net profits for the past year amounted to 14,230,000 mks., as compared with 19,170,000 mks. in 1929, while the total turnover declined during the year by 60,000,000 mks. to 520,000,000 mks.

The joint secretaries of the Board of Conciliation for the regulation of wages in the pig-iron trade of Scotland have been informed by the accountants that an examination of the employers' books for October, November and December, 1930, gives an average net selling price of £3 15s. 11d. This means that there will be a reduction of 1 per cent. on basic rates in the wages of the workmen.

Messrs. Cochran & Company, Annan, Limited, have secured an order for a Ruth's steam accumulator for installation in a sugar refinery at Greenock. The size of the accumulator is 14 ft. 9 in. dia. by 51 ft. by 7,870 cub. ft. capacity. An interesting feature of the order is that, owing to the difficulties of overland transport, Messrs. Cochran & Company have arranged for towage to Greenock from the Solway by tug.

Mr. A. Fraser, who has been chief representative in Scotland for Messrs. Sir W. G. Armstrong, Whitworth & Company, Limited, during the past twelve years, has commenced business on his own account as Alexander Fraser & Company. He will continue to act as agent at the same offices, Atlantic Chambers, 45, Hope Street, Glasgow, for Sir W. G. Armstrong, Whitworth & Company (Engineers), Limited, Sir W. G. Armstrong, Whitworth & Company (Ironfounders), Limited, Craven Bros. (Manchester), Limited, Bostock & Bramley, Limited, and in addition will carry on other engineering agencies.

An innovation in the Trade Union movement was introduced by the General Iron Fitters on the occasion of the opening of their new hall in Callendar Riggs, Falkirk. A singing contest was arranged, open to members in Falkirk and district, with a view to discovering the standard of talent within the membership of the union. The standard proved to be well above the average, and the prizes were ultimately awarded to Mr. Robert Kay (Carron Company, Mungal Foundry), Mr. T. Butler (Allied Iron Founders, Limited, Sunnyside Foundry), and Mr. J. Clark (Messrs. Jones & Campbell, Limited, Torwood Foundry, Larbert).

Granting the petition of a number of shareholders of the company, Vice-Chancellor Backes, of Newark, New Jersey, recently issued an order requiring the Bethlehem Steel Corporation and 13 of its officers and directors to show cause why they should not give an accounting for $36,498,668 paid as bonuses over a period from January 1, 1911, to June 13, 1930. Among the defendants are Mr. Charles M. Schwab, chairman of the board, who is said to have directed the distribution of the bonuses, Mr. Eugene G. Grace, the President, and a number of other officers of the corporation, who are said to have received bonuses.

A new trade school is being erected in the Garnethill district of Glasgow by the Education Committee of the Corporation, at a cost of over £100,000. It will be fitted throughout with the most up-to-date equipment for the instruction of apprentice tradesmen in a wide variety of technical subjects. Classes in the various subjects are instituted only at the request of an advisory committee of the employers concerned. Instruction will be provided in fully 20 subjects, including engineering, foundry work, patternmaking, boilermaking and vehicle building. There will also be drawing offices and physical, chemical and research laboratories.

With the encouragement of their Government, Japanese steelmakers have adopted a plan to secure a practical monopoly in China and other Eastern markets. The Japanese State iron and steel works at Yawata are to amalgamate with all the private steel companies of Japan, as foreshadowed in our issue for June 20. Management is to be evenly divided between the officials of the State works and those operating the private enterprises. The new combination will be capitalised at the equivalent of £60,000,000. The scheme includes proposals for controlling steel imports into Japan, for establishing stockyards in China, and for centralisation of the banking business required in financing steel production.

The Electricity Commissioners have given their consent to the erection of the proposed super-power station at Fulham (London) to which certain public bodies, as well as local residents, had raised objection. The Commissioners, having examined alternative proposals, state in their report that the case in favour of the extension of the present station in Townmead Road is conclusive, both on technical and financial grounds. The consent places the Borough Council under statutory obligation not to work the station so as to occasion a nuisance, and to that end to use the most efficient methods for elimination of smoke and grit; prevention of the discharge of sulphur and its compounds into the atmosphere; and the avoidance of noise or vibration.

Mr. Arthur Greenwood, Minister of Health, in his presidential address at the annual conference of the University Labour Federation at Liverpool last month, said that social control over private enterprise inevitably became closer. Even during the heyday of industrialism, the State had in the national interest to subject industries to regulation. reluctance or inability of certain industries to adapt themselves to new conditions had led to Government intervention in matters of high industrial policy. The Coal Mines Act, for example, represented a new development in the relations between the State and industry, and it might well be that, in the absence of voluntary reorganisation in the iron and steel trades and the cotton industry, a measure of compulsion by legislation would be necessary.

Obituary.

Mr. F. E. Sankey, a director of Messrs. Joseph Sankey & Sons, Limited, Bilston, died recently at his home in Wolverhampton, aged 65.

Mr. William Flowman, who for the last 18 years was cashier to the Bon-Accord Engineering Company, Limited, Mill Lane, Aberdeen, died on January 27.

Mr. J. E. S. Bache, a director of Messrs. George Salter & Company, Limited, brass and iron founders, of West Bromwich, died recently at his home in Kidderminster, aged 43.

Mr. Richard Ridgill Allison, formerly of Messrs. Kitson & Company, Limited, Airedale Foundry, Leeds, died recently. Mr. Allison was 91 years of age, and retired in 1920.

The death occurred at his home in Larbert, on January 29, of Mr. William Kemp, works manager of the Falkirk Iron Company, Limited. Mr. Kemp had been in the employ of the Falkirk Company for 46 years; he started in the patternshop, eventually became foreman patternmaker, and in 1915 was appointed works manager.

Mr. Andrew Laing, managing director of the Wallsend Slipway & Engineering Company, Limited, died at Newcastle-upon-Tyne on Saturday, January 24. He was 75 years of age. Mr. Laing designed the engines of the Cunard liner "Mauretania." He was a director of Messrs. Swan, Hunter & Wigham Richardson, Limited, shipbuilders, of Wallsend.

M. Gustave Trasenster, President of the Ougrée group of companies, died suddenly at St. Raphael, Alpes Maritimes, France, on January 24, aged 75. He was President of the board of the Ste. Ame. d'Ougrée-Marihaye, and was also interested in numerous other industrial undertakings in Belgium. Amongst others, he was chairman of the following companies:—Ste. Belge de l'Azote, Ste. Commerciale de Belgique, and Tubes de la Meuse. He was also chairman of the Belgian Steel Cartel and chairman of the Association of Coal Mines and Steel Works of the Province of Liége. He was Vice-President of the Central Industrial Committee of Belgium, which association takes a leading part in the economic life of Belgium. He enjoyed the highest reputation in the business world in Belgium and abroad. In July, 1930, on the occasion of his 50th anniversary as the head of the Ougrée group, he was appointed by the King of the Belgians "Grand Officier de l'ordre de Leopold." The French Government, also recognising his services, granted him the Cross of the Grand Officer of the Legion d'honneur.

Personal.

Mr. George Summers, general manager of the Stirling Boiler Company, Limited, has been elected a director of the company.

Mr. John Alexander, Mr. George S. Cromar and Mr. George Barrie, departmental managers at the shipbuilding and engineering establishment of Messrs. Barclay, Curle & Company, Limited, Whiteinch, Glasgow, have been elected directors of the company.

Mr. John Cocks, joint managing director of the Shelton Iron, Steel & Coal Company, Limited, and President of the North Staffordshire Colliery Owners' Association, was the recipient of a presentation at a gathering in his honour at Stoke-on-Trent on Monday, January 26, in appreciation of his having occupied the presidency of the Association for six years, and also having acted as chairman of the District Wages Board and various other associations and organisations in connection with the coal trade of the district.

New Companies.

Corrosion-Resisting Metals, Limited, Providence Street, Cradley Heath, Staffs.—Capital £3,000. Directors: J. Hathaway and G. H. R. H. Powell.

Crabtree (1931), Limited.—Capital £10,000. Shipbuilders, mechanical engineers, founders, etc. Directors: J. S. Beddows, 44, Alexandra Road, Lowestoft; A. Smith, Henry M. Fellows and C. W. Dance.

Hydrautomat (1931), Limited, Victoria Station House, Victoria Street, London, S.W.—Capital £10,000 in 5s. shares. Iron founders, machinery manufacturers, etc. Directors: T. G. Allen, J. O. Boving, L. E. B. Homan and Lt.-Col. J. A. Stirling.

Metal Sections, Limited, River Lee Road, Greet, Birmingham.—Capital £2,500. Metal rollers, die sinkers and casters, etc. Secretary: D. M. Moffat.

YORKSHIRE SAND

(IN FOUR GRADES)

IS

ALL—BRITISH

S S S

IT IS THE STRONGEST

AND

MOST ECONOMICAL

STEEL FOUNDRY

SAND EVER KNOWN

ASK US TO PROVE IT!

GENERAL REFRACTORIES LTD.,
SHEFFIELD.
(Tel. 22311.)

Iron and Steel Markets.

Pig-Iron.

MIDDLESBROUGH.—There has been a gradual improvement in the position of the Cleveland pig-iron trade during the past few weeks. The expansion has been slow, but perhaps on that account it is more satisfactory, for sudden spasms of activity are seldom beneficial in the long run. The steel-works are getting more work, an additional steel furnace being restarted at the Dorman, Long works, which means that more iron will pass direct from the blast furnaces to the steel shops. The improvement, however, extends also to the general merchant trade. In Scotland trade is poor, and special prices have still to be quoted to get business, as foreign competition is very keen. But the sales of pig-iron to North of England consumers are distinctly better. The export trade continues to be very dull. However, it now seems to be established that the last price cut has definitely stopped the purchase by local consumers of Midlands and foreign iron, and Cleveland has at least become self-supporting in the matter of pig-iron supplies. The fixed minimum quotations for the various grades of Cleveland iron are:—No. 3 Cleveland G.M.B., 58s. 6d. per ton; No. 1 foundry iron, 61s.; No. 4 foundry, 57s. 6d.; No. 4 forge, 57s.

The hematite market is less satisfactory. Consumers evidently think they are entitled to a reduction in view of the fall in foundry-iron prices, and the makers have been unable to adhere to their quotation of 70s. per ton for East Coast mixed numbers, despite the restriction of the output. Now 69s. per ton is generally accepted, and it is not certain that that is the lowest possible figure. On the North-West Coast, Bessemer mixed numbers are lower at 68s. per ton at works.

LANCASHIRE.—There has been a disappointing absence of any real weight of orders during the past week, as foundry-iron consumers on this market have not yet made up their minds that prices have touched bottom. Derbyshire and Staffordshire No. 3, for delivery to users in the Manchester price zone, is offered at 69s. 6d. per ton, Derbyshire forge at 64s. 6d., Northamptonshire foundry at 68s., Cleveland at around 71s., Scottish brands of No. 3 at 90s. to 91s., and West Coast hematite iron at from 84s. to 84s. 6d. per ton.

THE MIDLANDS.—The foundry pig-iron market was rather featureless during the past week. At the meeting of the Midland pig-iron producers no change in price was made so far as the Midland area is concerned. Many consumers had been waiting for this meeting in the hope that the iron-founders would ease prices in an endeavour to stimulate trade, and the absence of any reduction came somewhat as a surprise. Values are therefore unchanged at 67s. 6d. for No. 3 Northants and 71s. for Derbyshire and Staffordshire No. 3, these figures including delivery to local stations.

SCOTLAND.—Despite the recent reduction in the price of Scottish iron, business in the pig-iron market is abnormally quiet. The export demand is also extremely poor. No. 3 Scotch foundry iron is at 73s. 6d. f.o.t. furnaces, with a minimum of 2s. 6d. per ton extra for No. 1 quality.

Finished Iron.

There has been no improvement in this market. None of the mills is working to capacity, most of them operating only fitfully, and it is impossible for the mills making crown and nut and bolt iron to get sufficient business to warrant regular working. Crown bars are offered in the Midlands at £9 15s. to £10 5s., and in some cases lower. Bolt iron is at £8 15s. and upwards, but little support is possible for iron of this nature because of the low prices at which the Belgian product is coming through. Belgian No. 3 iron is being quoted at £5 2s. 6d. to £5 5s., delivered consumers' works in the Darlaston district. Staffordshire marked bars are at £12 10s. at works.

Steel.

Business in finished steel is more active, although in all districts the demand still leaves much to be desired. No improvement can be reported in the position of galvanised sheets, the lower prices of which have not in any way stimulated the demand. Prices of Continental semi-finished steel appear to have undergone no further decline during the week. The demand all round is very quiet, consumers appearing to have covered their requirements a good way ahead. Little business, therefore, is being placed with either the British or Continental works.

Scrap.

Cleveland merchants affirm that business has seldom been in such a state of utter stagnation, and the only transactions possible are limited to small parcels for immediate delivery. However, prices do not show any further decline. Ordinary quality cast-iron scrap is at 48s. per ton, with machinery quality at 51s. No great amount of business has been transacted in the Midlands during the past week, although the tone is certainly firmer. Heavy machinery cast-iron scrap is offered at 60s. delivered, and ordinary heavy metal at 57s. 6d., with light cast-iron scrap at 45s. delivered. In Scotland the iron and steel scrap market remains in a difficult position, and there is no indication of an improvement. Owing to scarcity of orders, stocks at the works have accumulated, and it is difficult to find an outlet for any quality. First-quality machinery cast-iron scrap, suitable for foundries, is at 55s., with ordinary cast iron to the same specification at 51s. 3d., cast-iron railway chairs 54s., light metal 40s., and furnace firebars at 37s. 6d. The above prices are all per ton delivered f.o.t. consumers' works.

Metals.

Copper.—The standard market is rather featureless, but there has been a moderate turnover at easier prices. Buying by consumers has not been so good on either side of the Atlantic, and the promise of a favourable development among domestic users in the United States has not materialised. If demand does not improve it is almost certain that there will be a general marking down of values, for as long as the trade remains in the hands of the Customs smelters, who have to sell their intake daily, price remains to some extent a secondary consideration.

Closing quotations :—

Cash.—Thursday, £44 to £44 1s. 3d.; Friday, £44 2s. 6d. to £44 5s.; Monday, £43 11s. 3d. to £43 12s. 6d.; Tuesday, £43 8s. 9d. to £43 10s.; Wednesday, £43 15s. to £43 17s. 6d.

Three Months.—Thursday, £43 18s. 9d. to £44; Friday, £44 1s. 3d. to £44 2s. 6d.; Monday, £43 7s. 6d. to £43 8s. 9d.; Tuesday, £43 3s. 9d. to £43 5s.; Wednesday, £43 7s. 6d. to £43 10s.

Tin.—Interest in this market is mainly centred on the possibilities of the quota scheme, if it is adopted. News on this subject is still daily awaited, but the delay in making a fresh announcement is presumably due to the various difficulties which seem to have been encountered. In America there are indications of some recovery from the worst in the tin-consuming industries. The tinplate mills, which were working at about 45 per cent. of capacity at the end of November, have improved to about 60 per cent., and a steady if slow gain is anticipated in the next few months. The motor-car trade also appears to be rather more active.

Official closing prices :—

Cash.—Thursday, £113 17s. 6d. to £114; Friday, £113 17s. 6d. to £114; Monday, £113 7s. 6d. to £113 10s.; Tuesday, £112 2s. 6d. to £112 5s.; Wednesday, £114 12s. 6d. to £114 15s.

Three Months. — Thursday, £115 10s. to £115 12s. 6d.; Friday, £115 5s. to £115 7s. 6d.; Monday, £114 15s. to £114 17s. 6d.; Tuesday, £113 12s. 6d. to £113 15s.; Wednesday, £116 2s. 6d. to £116 5s.

Spelter.—Consumers have only shown moderate interest, and under present conditions it is evident that even a low price does not tempt them. Trade demand remains very dull, and the market has been flat on prospective heavy arrivals.

Daily fluctuations :—

Ordinary.—Thursday, £12 5s.; Friday, £12 5s.; Monday, £11 17s. 6d.; Tuesday, £11 15s.; Wednesday, £11 11s. 3d.

Lead.—Absence of demand and the weakness of other metals have contributed to bring down the price of this metal, and with trade so quiet it is possible that still lower values will be seen.

The week's prices have been :—

Soft Foreign (Prompt).—Thursday, £13 3s. 9d.; Friday, £13 3s. 9d.; Monday, £12 18s. 9d.; Tuesday, £12 18s. 9d.; Wednesday, £12 16s. 3d.

Students' Corner.

(*Continued from page* 80.)

Q.—For what purpose are stoppers, and of what are they made?

For small castings, in place of the usual stoppers, pieces of tin and very thin sheet iron, usually perforated, are employed to cover the down-gates, as these melt very quickly. In addition, to obtain a clean casting, dross head and dross traps are applied. In many cases stoppers are used to control the pouring. Where several down-gates are used, sufficient stoppers only are lifted as is deemed necessary for the proper rate of pouring. In other cases, where in-gates are located below and above in a casting, the top in-gate is generally used as an auxiliary runner; it remains covered by the stopper until the moment desired either for flushing up, or increasing the pouring rate towards the finish of the cast, when the remaining stopper, or stoppers, are lifted.

Q.—What are dross heads and dross traps? How do they function?

A.—The function of a dross head is to allow a means of escape of accumulated, locked-up, scum and dirt, due chiefly to erosion whilst pouring the casting. An exit is provided which may be large, or small, according to the dimensions of the mould, and is located where such is apt to gather. A dross trap, in the absence of adequate sketches, is difficult to describe. Their purpose is a precautionary attempt to prevent any scum or sand entering the mould. They are situate in a direct line, and in close proximity to the in-gates. They assume various forms, such as the core-gate trap, or the egg-shape trap, or swirl gate.

Q.—Of what importance are risers, and their purpose generally?

A.—Risers are put on castings for various purposes, and very often for no apparent reason, but simply from habit alone. Some legitimate uses for risers may be enumerated as follows:—Ordinary risers only are now referred to, which do not include feeding, dross or dummy risers. It is common practice for 4 to 6 cut-off risers (*i.e.*, cut-off level with the joint of the mould) to be placed on such castings as large bed-plates and the like. These risers serve a useful purpose when run off the level of the top box-part or cope. Usually the pouring basins are about 12 in. high above the top of the box. Hence the risers reduce the liquid pressure on the mould in all directions, providing they are flowed off on the level of the top box or cope, as this is below the level of the pouring basin box. Such risers also indicate to the pourer when the mould is full. If any blowing occurs, some metal may be run through, although this does not often do much good unless the blowing arises from a cause near the riser which may be in a direct line with an in-gate, otherwise much fluid metal is often wasted by running through the risers. The liquid metal follows the line of least resistance as long as it remains fluid, and often misses the blowing area.

(*To be continued.*)

GREAT ECONOMY!

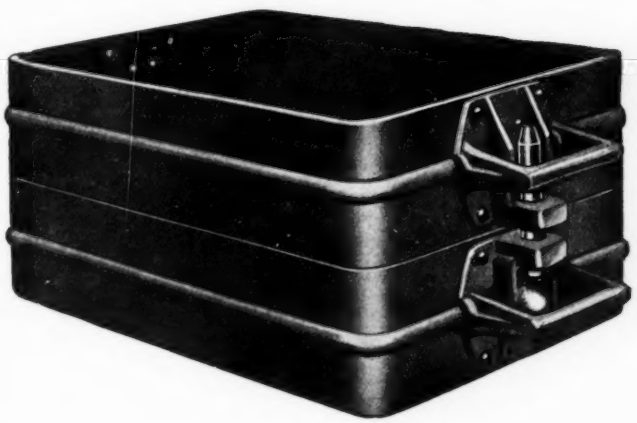
ONE of the greatest improvements you can introduce into your foundry is the STERLING ROLLED STEEL MOULDING BOX.

The result will be economy all round.

Your moulders will put down more moulds per day because STERLING BOXES are light and easy to handle;

You will be sure of an accurate product because STERLING BOXES are accurately made and maintain this accuracy permanently;

Your box maintenance costs will be at least halved because however heavy the service STERLINGS cannot crack or break.



Makers of
MOULDING BOXES
for every
FOUNDRY SERVICE

STERLING FOUNDRY SPECIALTIES LTD.

London Office:
13, VICTORIA STREET, S.W.1.

BEDFORD.

Telephone: 3345 BEDFORD.
Telegrams: "STERFLASK, BEDFORD."
Code: WESTERN UNION.

Glasgow: ALBERT SMITH & CO., 60, ST. ENOCH SQUARE, GLASGOW, C.1.
Newcastle-on-Tyne: LAWSON, WALTON & CO., LTD., HANDYSIDE ARCADE, NEWCASTLE-ON-TYNE.
Manchester: F. L. HUNT & CO., CHAPEL STREET, SALFORD, MANCHESTER.

WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash	43	15	0
Three months	43	7	6
Electrolytic	46	0	0
Tough	44	0	0
Best selected	44	10	0
Sheets	75	0	0
India	55	10	0
Wire bars	46	8	9
Do. March	46	8	9
Do. April	46	8	9
Ingot bars	46	8	9
H.C. wire rods	48	5	0
Off. av. cash, January	44	19	7 5/16
Do., 3 mths. January	44	17	6 3/4
Do., Sttlmnt., January	44	19	4 7/8
Do., Electro, January	47	17	11 1/2
Do., B.S., January	46	14	2
Do., wire bars, January	48	5	5 7/8
Solid drawn tubes			11 1/4d.
Brazed tubes			11 1/2d.
Wire			7 3/4d.

BRASS.

Solid drawn tubes	10d.
Brazed tubes	12d.
Rods, drawn	9 3/4d.
Rods, extd. or rlld.	5 1/2d.
Sheets to 10 w.g.	8 1/4d.
Wire	8 3/4d.
Rolled metal	7 1/4d.
Yellow metal rods	5 1/4d.
Do. 4 × 4 Squares	6 1/2d.
Do. 4 × 3 Sheets	6 3/4d.

TIN.

	£	s.	d.
Standard cash	114	12	6
Three months	116	2	6
English	116	0	0
Bars	113	0	0
Straits	113	2	6
Australian	111	12	6
Eastern	114	5	0
Banca	113	12	6
Off. av. cash, January	115	17	7 3/8
Do., 3 mths., January	117	5	8 1/4
Do., Sttlmt., January	115	17	10 5/8

SPELTER.

	£	s.	d.
Ordinary	11	11	3
Remelted	11	0	0
Hard	9	10	0
Electro 99.9	14	0	0
English	12	5	0
India	11	0	0
Zinc dust	18	15	0
Zinc ashes	3	0	0
Off. aver., January	12	18	7 5/16
Aver., spot, January	12	14	11 1/2

LEAD.

	£	s.	d.
Soft foreign ppt.	12	16	3
English	14	5	0
Off. average, January	13	17	9 5/16
Average spot, January	13	17	5 1/2

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	21	0	0
Do. V.M. ex-whf.	20	0	0
Rods	24	0	0
Boiler plates	14	15	0
Battery plates	16	15	0

ANTIMONY.

	£	s.	d.
Special brand, Eng.	36	0	0
Chinese	25	0	0
Crude	22	0	0

QUICKSILVER.

	£	s.	d.
Quicksilver	22	7	6

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—	
25%	£7 15 0
45/50%	£11 10 0
75%	£18 10 0
Ferro-vanadium—	
35/50%	12/8 lb. Va.
Ferro-molybdenum—	
70/75% c. free	4/2 lb. Mo.
Ferro-titanium—	
23/25% carbon-free	9d. lb.
Ferro-phosphorus, 20/25%	£15 12 6
Ferro-tungsten—	
80/85%	2/- lb.
Tungsten metal powder—	
98/99%	2/3 lb.
Ferro-chrome—	
2/4% car.	£30 0 0
4/6% car.	£23 2 6
6/8% car.	£22 7 6
8/10% car.	£21 17 6
Ferro-chrome—	
Max. 2% car.	£32 15 0
Max. 1% car.	£36 17 6
Max. 0.70% car.	£39 15 0
70% carbon-free	10d. lb.
Nickel—99% £170 0 0	to £175 0 0
Ferro-cobalt	9/4 lb.
Aluminium 98/99%	£85 0 0
Metallic chromium—	
96/98%	2/7 lb.
Ferro-manganese (net)—	
76/80% loose	£11 5 0
76/80% packed	£12 5 0
76/80% export	£11 0 0
Metallic manganese—	
94/96% carbonless	1/4 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	£0 2 2
Finished bars, 18% tungsten	£0 3 0

Per lb. net, d/d buyers' works.

Extras—	
Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to 7/32 in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ½ in.	3d. lb.
Do., under ½ in. × ¼ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP.

South Wales—	£	s.	d.		£	s.	d.
Heavy steel					2	7	6
Bundled steel and shrngs.	1	15	0	to 1	18	0	
Mixed iron and steel	1	17	6	to 2	0	0	
Heavy cast iron					2	7	6
Good machinery for foundries					2	10	0
Cleveland—							
Heavy steel					2	6	0
Steel turnings					1	12	6
Cast-iron borings					1	8	6
Heavy forge					3	2	6
W.I. piling scrap					2	12	6
Cast-iron scrap	2	8	0	to 2	11	0	
Midlands—							
Light cast-iron scrap					2	5	0
Heavy wrought					3	0	0
Steel turnings						—	
Scotland—							
Heavy steel					2	7	6
Ordinary cast iron					2	11	3
Engineers' turnings					1	12	6
Cast-iron borings					1	12	6
Wrought-iron piling					2	17	6
Heavy machinery					2	15	0

London—Merchants' buying prices delivered yard.

	£	s.	d.
Copper (clean)	37	0	0
Brass	26	0	0
Lead (less usual draft)	11	0	0
Tea lead	8	0	0
Zinc	5	10	0
New aluminium cuttings	50	0	0
Braziery copper	34	0	0
Gunmetal	35	0	0
Hollow pewter	76	0	0
Shaped black pewter	56	0	0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast—	
Foundry No. 1	61/-
Foundry No. 3	58/6
Foundry No. 4	57/6
Forge No. 4	57/-
Hematite No. 1	69/6
Hematite M/Nos.	69/-
N.W. Coast—	
Hem. M/Nos. d/d Glas.	77/6
„ d/d Birm.	88/6
Midlands—	
Staffs. common*	—
„ No. 4 forge*	66/-
„ No. 3 fdry.*	71/-
Shrops. basic	—
„ Cold blast, ord.	—
„ „ roll iron	—
Northants forge*	62/6
„ fdry. No. 3*	67/6
Derbyshire forge*	66/-
„ fdry. No. 3*	71/-
„ basic*	—

*d/d Black Country dist.

Scotland—	
Foundry No. 1	76/-
„ No. 3	73/6
Hem. M/Nos.	75/-
Sheffield (d/d district)—	
Derby forge	61/-
„ fdry. No. 3	66/-
Lincs. forge	—
„ fdry. No. 3	66/-
E.C. hematite	82/6
W.C. hematite	86/6
Lincs. (at furnaces)—	
Forge No. 4	—
Foundry No. 3	—
Basic	—
Lancashire (d/d eq. Man.)—	
Derby forge	64/6
„ fdry. No. 3	69/6
Staffs foundry No. 3	69/6
Dalzell, No. 3 (special)	105/- to 107/6
Summerlee, No. 3	90/- to 91/-
Glengarnock, No. 3	—
Eglinton, No. 3	90/- to 91/-
Gartsherrie, No. 3	90/- to 91/-
Monkland, No. 3	90/- to 91/-
Shotts, No. 3	90/- to 91/-

FINISHED IRON AND STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£	s.	d.		£	s.	d.
Bars (cr.)	10	0	0	to 10	10	0	
Nut and bolt iron					8	15	0
Hoops	10	15	0	to 12	0	0	
Marked bars (Staffs) f.o.t.					12	10	0
Gas strip	10	15	0	to 12	0	0	
Bolts and nuts, ½ in. × 4 in.	14	5	0				
Steel—							
Ship plates	8	15	0	to 8	17	6	
Boiler plts.	9	5	0	to 10	5	0	
Chequer plts.					10	12	6
Angles					8	7	6
Tees					9	7	6
Joists					8	15	0
Rounds and squares, 3 in. to 5½ in.					9	7	6
Rounds under 3 in. to ½ in. (Untested)					7	12	6
							and upwards
Flats—8 in. wide and over					8	12	6
„ under 8 in. and over 5in.					8	17	6
Rails, heavy	8	5	0	to 8	10	0	
Fishplates					12	0	0
Hoops (Staffs)	9	5	0	to 9	10	0	
Black sheets, 24g.	8	10	0	to 9	10	0	
Galv.cor.shts., 24g.					11	0	0
Galv. fencing wire, 8g. plain					12	0	0
Billets, soft	5	10	0	& up.			
Billets, hard	7	2	6	& up.			
Sheet bars	5	0	0	to 5	12	6	
Tin bars	5	0	0	to 5	12	6	

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	1/0½
Sheet to 10 w.g.	1/0¾
Wire	1/1
Rods	1/0½
Tubes	1/5¼
Castings	1/0¼

Delivery 3 cwt. free.
10% phos. cop. £30 above B.S.
15% phos. cop. £35 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. Clifford & Son, Limited.

NICKEL SILVER, &c.

	per lb.
Ingots for raising	7d. to 1/1
Rolled—	
To 9 in. wide	1/1 to 1/7
To 12 in. wide	1/1½ to 1/7½
To 15 in. wide	1/1½ to 1/7½
To 18 in. wide	1/2 to 1/8
To 21 in. wide	1/2½ to 1/8½
To 25 in. wide	1/3 to 1/9
Ingots for spoons and forks	7d. to 1/3½
Ingots rolled to spoon size	10d. to 1/6½
Wire round—	
3/0 to 10 G.	1/4½ to 1/11½

with extras according to gauge.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	17.76
No. 2 foundry, Valley	17.00
No. 2 foundry, Birm.	14.00
Basic	18.76
Bessemer	19.26
Malleable	19.26
Grey forge	18.26
Ferro-mang. 80%	80.00
O.-h. rails, h'y, at mill	43.00
Billets	30.00
Sheet bars	30.00
Wire rods	36.00
	Cents.
Iron bars, Phila.	2.09
Steel bars	1.65
Tank plates	1.65
Beams, etc.	1.65
Skelp, grooved steel	1.60
Skelp, sheared steel	1.60
Steel hoops	1.90
Sheets, black, No. 24	2.35
Sheets, galv., No. 24	2.90
Sheets, blue an'l'd, No. 13	2.05
Wire nails	1.90
Plain wire	2.30
Barbed wire, galv.	2.55
Tinplates, 100-lb. box	$5.00

COKE (at ovens).

Welsh foundry	25/-
„ furnace	16/-
Durham and Northumberland—	
„ foundry	14/6
„ furnace	14/6
Midlands, foundry	—
„ furnace	—

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. cokes	20×14 box	15/6
„	28×20 „	31/-
„	20×10 „	22/9
„	18¾×14 „	16/3
C.W.	20×14 „	15/-
„	28×20 „	29/6
„	20×10 „	21/-
„	18¾×14 „	16/-
Terneplates	28×20	31/- per box basis f.o.b.

SWEDISH CHARCOAL IRON & STEEL.

Pig-iron	£6	0	0	to £7	10	0	
Bars, hammered, basis	£17	10	0	to £18	10	0	
Bars and nail-rods, rolled, basis	£15	17	6	to £16	15	0	
Blooms	£10	0	0	to £12	0	0	
Keg steel	£32	0	0	to £33	0	0	
Faggot steel	£20	0	0	to £24	0	0	
Bars and rods dead soft, steel	£11	0	0	to £14	0	0	

All per English ton, f.o.b. Gothenburg.

TUBES AND FITTINGS.

Over ½ in. up to 6 in.

	Tubes.	*Fittings.*
Gas	62½%	47½%
Water ..	58½%	42½%
Steam ..	55%	37½%

W.I. 12½% extra.

DAILY FLUCTUATIONS.

Standard Copper (cash).

		£	s.	d.	
Jan.	29 ..	44	0	0	dec. 6/3
,,	30 ..	44	2	6	inc. 2/6
Feb.	2 ..	43	11	3	dec. 11/3
,,	3 ..	43	8	9	,, 2/6
,,	4 ..	43	15	0	inc. 6/3

Electrolytic Copper.

		£	s.	d.	
Jan.	29 ..	46	10	0	dec. 10/-
,,	30 ..	46	10	0	No change
Feb.	2 ..	46	0	0	dec. 10/-
,,	3 ..	45	10	0	,, 10/-
,,	4 ..	46	0	0	inc. 10/-

Standard Tin (cash).

		£	s.	d.	
Jan.	29 ..	113	17	6	dec. 27/6
,,	30 ..	113	17	6	No change
Feb.	2 ..	113	7	6	dec. 10/-
,,	3 ..	112	2	6	,, 25/-
,,	4 ..	114	12	6	inc. 50/-

Tin (English ingots).

		£	s.	d.	
Jan.	29 ..	115	5	0	dec. 22/6
,,	30 ..	115	5	0	No change
Feb.	2 ..	114	15	0	dec. 10/-
,,	3 ..	113	10	0	,, 25/-
,,	4 ..	116	0	0	inc. 50/-

Zinc Sheets (English).

		£	s.	d.	
Jan.	29 ..	21	0	0	dec. 10/-
,,	30 ..	21	0	0	No change
Feb.	2 ..	21	0	0	,, ,,
,,	3 ..	21	0	0	,, ,,
,,	4 ..	21	0	0	,, ,,

Spelter (ordinary).

		£	s.	d.	
Jan.	29 ..	12	5	0	No change
,,	30 ..	12	5	0	,, ,,
Feb.	2 ..	11	17	6	dec. 7/6
,,	3 ..	11	15	0	,, 2/6
,,	4 ..	11	11	3	,, 3/9

Lead (English).

		£	s.	d.	
Jan.	29 ..	14	10	0	dec. 5/-
,,	30 ..	14	10	0	No change
Feb.	2 ..	14	5	0	dec. 5/-
,,	3 ..	14	5	0	No change
,,	4 ..	14	5	0	,, ,,

AVERAGE MONTHLY PRICES OF STEEL SHIP ANGLES (NORTH OF ENGLAND).

Year.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1896	4 15 0	4 17 6	5 0 0	5 0 0	5 0 0	4 17 6	4 17 6	4 17 6	4 17 6	5 0 0	5 7 6	5 7 6	4 19 9½
1897	5 7 6	5 7 6	5 7 6	5 5 0	5 0 0	5 0 0	5 2 6	5 2 6	5 2 6	5 2 6	5 0 0	5 5 0	5 3 5½
1898	5 5 0	5 5 0	5 5 0	5 7 6	5 13 9	5 15 0	5 15 0	5 15 0	5 17 6	6 0 0	6 5 0	6 7 6	5 14 3
1899	6 10 0	6 12 6	6 15 0	6 15 0	6 17 6	7 0 0	7 0 0	7 5 0	8 2 6	8 2 6	8 0 0	7 10 0	7 0 5
1900	7 15 0	8 0 0	8 2 6	8 5 0	8 5 0	8 7 6	8 7 6	8 2 6	8 2 6	8 0 0	7 12 6	7 15 0	8 0 7½
1901	6 15 0	6 12 6	6 5 0	6 0 0	6 0 0	5 10 0	5 15 0	5 17 6	6 0 0	5 17 6	5 17 6	5 15 0	6 0 5
1902	5 12 6	5 10 0	5 10 0	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 7 6	5 11 8
1903	5 6 3	5 6 3	5 7 6	5 12 6	5 12 6	5 12 6	5 10 0	5 10 0	5 10 0	5 10 0	5 10 0	5 0 0	5 8 9
1904	5 0 0	4 17 6	5 2 6	5 5 0	5 5 0	5 5 0	5 5 0	5 5 0	5 0 0	5 0 0	5 0 0	5 5 0	5 2 6
1905	5 5 0	5 7 6	5 10 0	5 10 0	5 10 0	5 10 0	5 10 0	5 10 0	5 12 6	6 2 6	6 12 6	6 12 6	5 14 4½
1906	6 12 6	6 12 6	6 12 6	6 12 6	6 12 6	6 12 6	6 12 6	6 12 6	6 12 6	6 12 6	6 12 6	7 2 6	6 13 4
1907	6 17 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	6 12 6	6 12 6	7 0 5
1908	6 2 6	6 2 6	6 2 6	5 17 6	5 17 6	5 17 6	5 17 6	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 16 3
1909	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 7 6	5 7 6	5 7 6	5 7 6	5 7 6	5 7 6	5 7 6	5 9 7
1910	5 16 3	5 17 6	5 17 6	6 1 6	6 2 6	6 2 6	6 2 6	6 2 6	6 2 6	6 7 6	6 7 6	6 7 6	6 2 3½
1911	6 7 6	6 7 6	6 7 6	6 7 6	6 7 6	6 7 6	6 7 6	6 7 6	6 7 6	6 7 6	6 7 6	6 9 0	6 7 8½
1912	6 16 3	6 17 6	6 17 6	7 5 0	7 7 6	7 7 6	7 7 6	7 12 6	7 12 6	7 12 6	7 14 6	7 17 6	7 7 4½
1913	7 17 6	7 17 6	7 17 6	7 17 6	7 17 6	7 17 6	7 17 6	7 7 6	6 15 6	6 7 6	6 7 6	6 2 6	7 8 11½
1914	6 2 6	6 2 6	6 2 6	6 2 6	6 2 6	5 15 0	5 15 0	6 15 0	7 0 0	7 0 0	7 1 3	7 5 0	6 8 7½
1915	7 17 0	8 5 0	8 17 6	9 5 0	9 5 0	9 15 0	9 15 0	9 15 0	9 15 0	9 15 0	10 15 0	10 15 0	9 8 3½
1916	11 3 1½	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6
1917	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6
1918	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6
1919	11 2 6	13 12 6	13 12 6	13 12 6	17 2 6	17 1 3	17 0 0	17 15 0	17 15 0	17 15 0	17 17 6	18 5 0	16 1 9
1920	19 10 0	20 0 0	21 10 0	22 0 0	23 5 0	24 0 0	24 0 0	24 0 0	24 15 0	24 10 0	24 0 0	24 0 0	22 19 2
1921	22 10 0	20 12 6	19 0 0	17 10 0	17 10 0	16 6 0	14 10 0	14 3 4	13 10 0	11 15 0	10 0 0	9 12 6	15 11 7
1922	9 17 6	10 0 0	10 0 0	10 0 0	10 0 0	9 17 6	9 10 0	8 15 7½	8 14 0	8 12 6	8 12 6	8 12 6	9 7 8½
1923	8 18 1½	9 1 3	9 14 0	9 17 6	9 17 2	9 11 3	9 15 0	9 15 0	9 9 4½	9 6 6	9 5 0	9 5 0	9 13 1½
1924	10 0 0	9 18 1½	9 17 6	9 17 6	9 17 2	9 11 3	9 15 0	9 15 0	9 9 4½	9 6 6	9 5 0	9 5 0	9 13 1½
1925	9 2 0	9 0 11½	9 0 0	8 15 9	8 10 3½	8 9 0½	8 6 3	8 2 6	7 19 0½	7 12 3	7 5 0	7 2 6	8 5 5½
1926	7 2 6	7 2 6	7 2 6	7 3 4	7 2 6	7 3 9	7 7 6	7 8 5½	7 9 0	7 12 6	7 16 3	8 0 6	7 7 7½
1927	7 18 9	7 17 6	7 17 6	7 14 8½	7 13 9	7 12 6	7 12 6	7 12 6	7 12 6	7 12 6	7 12 6	7 12 6	7 14 1½
1928	7 12 6	7 14 9	7 17 6	7 17 6	7 17 6	7 17 6	7 17 6	7 17 6	7 17 6	7 17 6	7 17 6	7 17 6	7 16 10½
1929	7 17 6	7 17 6	7 17 6	7 17 6	8 0 6	8 2 6	8 2 6	8 2 6	8 2 6	8 2 6	8 2 6	8 5 0	8 0 10½
1930	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6
1931	8 7 6	—	—	—	—	—	—	—	—	—	—	—	—

WILLIAM JACKS & COMPANY,

WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

18, BENNETTS HILL, BIRMINGHAM.

PIG IRON

REGISTERED TRADE MARK

All grades FOUNDRY, HEMATITE, BASIC, SPECIALS, &c.

NON-FERROUS METALS

COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

WILLIAM JACKS & COMPANY,

19, ST. VINCENT PLACE, GLASGOW.

ZETLAND ROAD, MIDDLESBROUGH.

SMALL ADVERTISEMENTS.

Notice.

Small Advertisements in this section of the Journal are accepted at the prepaid rate of 6d. per line, first line in capitals counting two, average 6 words per line. Minimum charge for one insertion 3/-.

(A remittance should accompany instructions.)

SITUATIONS VACANT AND WANTED.

ELECTRIC Welder (Carbon Arc) desires change; 13 years' steel foundry experience; age 28.—Box 718, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

FOUNDRY MANAGER (42) SEEKS RE-ENGAGEMENT; practical, technical control foundries past 13½ years; expert working knowledge repetition and jobbing castings up to 50 tons for various branches engineering; economical production ordinary and high-duty metals. Highest references given.—Box 720, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

FOUNDRY Manager at liberty, with practical and commercial experience; I.B.F., F.M.B. member. All classes of work; rate-fixing. Good, sound references.—Box 700, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

FOUNDRY Foreman wanted in the South-East of England; must have experience in light repetition grey iron and malleable castings.—Box 716, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

WANTED, Foreman for Steel Foundry; must have experience with light castings.—Box 704, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

GARAGES FOR SALE.

SUSSEX (RYE).—The General Engineering Works known as The Rother Iron Works, comprising spacious Garage, Iron Foundry, Workshops, Lock-up Garages, 4 Cottages, for Sale by Auction (unless sold previously) on March 18 next.—For illustrated particulars apply, GEERING & COLYER, Rye, or JOHN BRAY & SONS, Bexhill-on-Sea.

PATENTS AND TRADE MARKS.

PROTECT YOUR IDEAS.—Free, Advice and Handbook on patenting inventions and registering trade marks by Registered Agent with 43 years' experience.—KING'S PATENT AGENCY, LIMITED, 146A, Queen Victoria Street, E.C.4.

NOTICE.

LEADING Company of Specialists in Germany is prepared to grant Manufacturing and Selling Licence for Great Britain for new Alloys withstanding Oxydation and Action of Acids (Castings, Rolled Material). Only applications of first-class firms of manufacturers possessing modern foundry and rolling mill equipment, preferably also facilities for plating process, can be considered.

Write to K. U. 9,378, c/o RUDOLF MOSSE, Cologne/Rh., Germany.

PROPERTY.

11 ACRES WORKS SITE.

SHEFFIELD.

145,000 Sq. Ft. of SHOPPING,

Compact and Convenient,

SIDING CONNECTIONS

with L.M. & S. and L. & N.E. Rlys.

WELL-BUILT & COMMODIOUS OFFICES

Will Sell whole or in lots to suit customers or Let on favourable terms. Unique opportunity for Manufacturers.

Apply—

THOS. W. WARD, LTD.,
ALBION WORKS, SHEFFIELD.

BRISTOL.

TO Engineers, Founders, Manufacturers.—Fine site of nearly three acres on arterial road, with Foundry and Workshops and own Rail Sidings into the premises. Modern Offices, Warehouses and Workrooms. Central Heating.—CHARLES A. TRICKS & SON, Auctioneers, St. Nicholas Street, Bristol.

MISCELLANEOUS.

GANISTER, best quality for cupolas, also for Steel Works.—ASTBURY SILICA COMPANY, "The Brooms," Park Lane, Congleton.

FOR Sale, large quantity Founders' Materials; Tools; Moulding Boxes; Core Barrels; Crucibles, etc., new and secondhand. Low prices. Further particulars on application.—KING'S, Garston, Liverpool.

FOUNDRY BLACKING.—Mineral, £3 10s.; Charcoal, £5; Plumbago, £13 ton, f.o.r. Iron Cement, 6d. lb. Case Hard Comp., 8d. lb. Samples.—COLMARS, 9, Earlsthorpe Road, S.E.26.

FOUNDRY LADLES.

ONE 5-ton Geared Ladle and one 6-ton Geared Ladle, for sale cheap.—For further details write, GRAHAMSLEYS, LIMITED, Newcastle-upon-Tyne.

MACHINERY.

WANTED, a Testing Machine, to test 2-in. x 1-in. cast-iron bars at 36-in. centres (transverse test).—Apply, Box 714, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

SAND MIXERS.—New and Secondhand. Ask us to quote.—W. BREALEY & COMPANY, LIMITED, Station Works, Ecclesfield, Sheffield.

THOS. W. WARD, LTD.

SAMSON Horizontal Surface Grinder, w.s. of table 24 in. x 6 in.

SCHUCHARDT & SCHUTTE Vertical Rotary Surface and Ring Grinder, magnetic chuck 11¾ in. dia., admit 8½ in. under stone.

BLANCHARD Type Vertical Surface Grinder, 220 volts d.c., 19½-in. dia. chuck.

HEALD No. 60 Internal Grinder, planetary head.

Four 6-wheel LOCOMOTIVES, 12-in. and 13-in. cylinders; copper fireboxes, brass tubes; 160 lbs. w.p.

6-ton LOCO. STEAM CRANE (Wilson), 35 ft. jib; two hoisting speeds; all motions; 4-ft. 8½-in. gauge and 7-ft. gauge; 90 lbs. w.p.

Four LANCASHIRE BOILERS, 30 ft. 0 in. x 8 ft. 0 in., re-insure 150 lbs. pressure.

One 20-n.h.p. PORTABLE STEAM ENGINE AND BOILER.

FOUNDRY LADLES, various types and sizes.

PRESSURE RECEIVERS, 24 ft. 0 in. x 4 ft. 6 in., hydraulically tested to 300 lbs. per sq. in.

(ASK FOR "ALBION" MACHINERY CATALOGUE.)

ALBION WORKS, SHEFFIELD.

'Phone: 287 SLOUGH

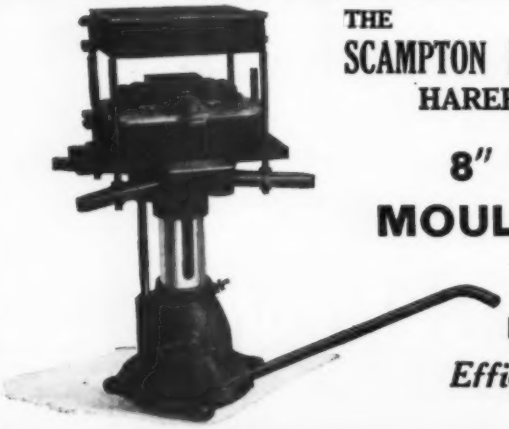
MOULDING MACHINES

1 "Coventry" headram squeezer, new	£22
2 Britannia No. 1 jolters, each	£36
1 Macdonald 24"×20" electric turnover	£40
1 Macdonald 24"×20" pneumatic turnover	£40
1 "Grimes" 36"×24" pneumatic turnover	£40
1 "Tabor" 40"×30" "Shockless" turnover	£130
1 "Tabor" 50"×42" "Shockless" plain jolt	£70
1 "Shockless" 72"×60" plain jolter	£90
4 Adaptable machines, standard type	£14

PLEASE NOTE PRICES!

BUY FROM ME AND SAVE MONEY!

ALEX. HAMMOND, *Foundry Machinery Merchant,*
14, AUSTRALIA ROAD, SLOUGH



THE
SCAMPTON FOUNDRY & MACHINE CO., LTD.
HAREFIELD ROAD, COVENTRY

8" PATTERN DRAW
MOULDING MACHINE
for
12" to 24"
MOULDING BOXES

Efficient—Robust—Foolproof

BRITISH MADE